THE SYMBIOTIC CLUSTER

– Pushing Textile Circularity Forward

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Abstract

The textile and clothing industry is one of the most harmful and wasteful industries in the world in terms of stress on the materials and natural resources that go into making textile products. The concept of a circular economy has been gaining ground in recent years as a way to counteract industries' negative impact on the environment. However, the concept has yet to take hold within the textile and clothing industry. This thesis proposes a systemic solution for textile and clothing companies to realize the potential for value-creation inherent in circular economy. As a multiple case study, the thesis isolates which specific obstacles against circular economy are experienced by the textile and clothing companies, identifies which changes are needed to enable the industry to realize circular value potential and proposes a concrete model that will bring about the needed changes. Findings show that for the configuration of the industry causes a lack of transparency in supply networks and spreads each activity in the companies' production process across the globe, making it difficult for the smaller companies to control and monitor their value chain, ultimately making it infeasible for them to attempt transitioning to a circular business model. The thesis proposes a model named The Symbiotic Cluster that can help SMEs eliminate the obstacles of the industry and thus realize the potential for circular value-creation. In The Symbiotic Cluster, companies engage in symbiotic exchanges of materials and resources, supported by the geographic and value-creation proximity advantages of an industrial cluster. This will permit SMEs to take control of their value chain activities and implement circular concepts that enhances the recyclability of textile products, ultimately creating value through forward and backward inter-firm linkages that reduce the stress on the environment.

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1. Introduction

The world is running out of resources. Raw materials are extracted in order to manufacture goods that are discarded at end-of-use as waste, putting a massive strain on the natural resources of the planet (Ellen MacArthur Foundation, 2015). Since the mid-20th century, the continuous adoption of linear business models has resulted in an exponential growth of negative environmental and social externalities (Ellen MacArthur Foundation, 2015). Today, most companies find themselves exposed to greater business risks such as higher commodity prices and increased price volatility as well as supply disruptions (World Economic Forum, 2014). These conditions combined with resource scarcity and the degradation of the global ecosystem are just some of the dynamics shaping the current business environment which the world's economy builds upon. The linear approach is gradually becoming a constraint on the global economy's future growth. Predictions made by McKinsey & Company estimate that three billion new middle-class consumers will enter the global market over the next 20 years (McKinsey & Company, 2016). Not only do these alarming factors place the world's natural resources under severe stress, they force companies worldwide to seek alternatives to linear practices.

In contrast to these linear practices, the concept of circular economy offers companies a economic model that is restorative and regenerative by design (Ellen MacArthur Foundation, 2015). In its most simple description, the goal of a circular economy is to rethink products and services to design waste out while it simultaneously attempts to minimize negative impacts (Ellen MacArthur Foundation, 2015). By focusing on systems optimization rather than components production, the circular economy attempts to rebuild economic, human and natural capital.

Over the past few years, the concept of circular economy has gained momentum within the business environment. At the present time, an estimated 9,1% of the global economy is circular (Circle Economy, 2018). Albeit its popularity, certain industries have failed to follow the trend and adopt circular business models. One of the industries still operating on a linear model is the textile and clothing industry. Global in nature, this particular industry is one of the most wasteful and polluting in the world (Ellen MacArthur Foundation, 2017).

The production of textiles and garments is based on tremendous amounts of non-renewable resources and most often, the garments are used for a very short period of time, after which the materials are eventually disposed of via a landfill or incineration (Ellen MacArthur Foundation, 2017). Moreover, the negative impacts such as the number of plastic microfibers entering our oceans, as well as material and water usage in water-scarce regions are set to put the profitability of the industry at risk. As a consequence, the linear production model pressures resources, pollutes and degrades the natural ecosystem and creates significant negative societal impacts at a local, regional and global scale (Global Fashion Agenda & Boston Consulting Group, 2017).

1.1 Problem Identification

Today, global value chains (GVCs) have become the most dominant feature of the global economy where different stages of production are geographically dispersed (OECD, 2015). Specific to the textile and clothing industry, the greatest part of companies organizes their production through global value chains. Considering the high degree of fragmentation and geographic distance between the value-adding activities of the global textile and clothing value chain in which companies are imbedded, the shift towards circular economy becomes both challenging and troublesome and impedes them from realizing circular value.

Not only does the current configuration of the global textile and clothing value chain represent a wide range of sourcing possibilities to the company, it also represents a complex business environment which companies have to understand and be able to tackle in order to unblock circular value. As the Boston Consulting Group explains the textile and clothing industry is *"highly fragmented, with thousands of actors involved and one of the most complex global production networks and supply chains. There is no standard path for the cotton produced in one country, spun in another, dyed and processed in a different one and converted into a garment in a factory way from the store"* (Global Fashion Agenda & Boston Consulting Group, 2017, p. 8).

1.2 Problem Statement & Research Question

The fact that circular economy poses such a potent source of value-creation, while the textile and clothing industry has not taken any substantial steps towards embracing circular economy is fascinating to us. International bodies and non-governmental organizations advocate ardently for a circular revolution, but companies within the textile and clothing industry still fail to change their production model into a circular one so that it fits within the boundaries of our ecosystem.

We view this incongruity as a very interesting subject issue to research; understanding exactly what keeps the textile and clothing industry from venturing into circular economy, when it is one of the industries that will suffer the most from staying in a linear economy. Therefore, the purpose of our study is to investigate how companies belonging to the industry can tackle the inadequacies experienced within the current global value chain in order to transform their business model and accomplish circular value:

- *How can companies within the textile and clothing industry organize themselves to realize the proposed value of circular business models?*

1.2.1 Sub-Questions

In order to answer our research question and obtain an in-depth understanding of the present conditions under which companies within the textile and clothing industry attempt to be circular, following sub-questions will be explored:

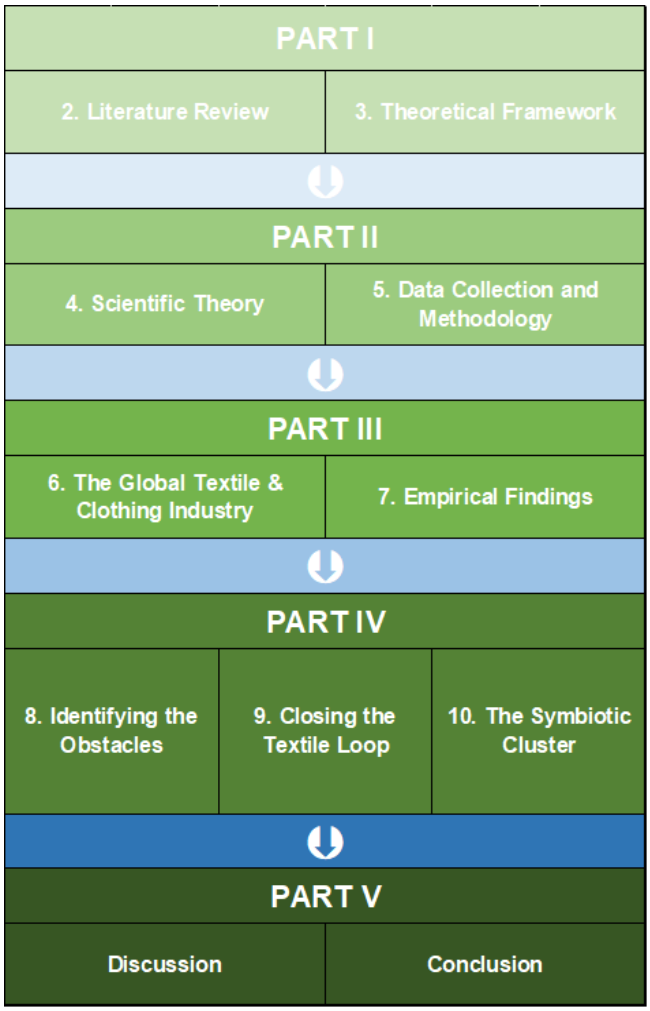
1. Which obstacles within the global textile and clothing value chain hinder circular value realization?
2. What are the systemic changes required to eradicate the obstacles, and how can these changes be implemented?
3. How can the changes help attain the four sources of value creation and what are the opportunities and threats involved?

1.3. Scope

In connection with our research question, a couple of boundaries are to be set in order to define the scope of our work. The choice to focus on the textile and clothing industry has specifically been made to illustrate the potential benefits of clustering production models given the highly fragmented and dispersed nature of the global value chain of the textile and clothing industry. To understand the organization of the production process additional factors could have been included such as: the demand for sustainable textiles; the competitiveness between the participants of the industry; the institutional environment textile and clothing companies pertain to on a national, international and supranational level; and the financing aspect of companies' strategic investments. We do recognize that these factors are relevant in shaping the production setup, however we have found it necessary to narrow the scope down to the organization of the industry, since the organization of the industry is an area with many aspects, and to cover it reasonably,

the focus needed to be kept on one aspect only, the activities embedded in the global textile and clothing value chain.

1.4. Structure of the Thesis



This paper is structured into five parts which altogether hold 14 chapters. The first part will focus on the literature review as well as on theoretical framework. The purpose of the literature review is to present the reader with the most recent developments in the different fields of study. The literature review will allow the reader to gain an overall understanding of the contributions made within each field of study. Following the same purpose, the theoretical framework is to introduce the reader to the theories that will be used to explain why our research problem exists as well as provide a scientific context to the analysis of our study's empirical findings.

The second part consists of the scientific theory, data collection and methodology that comprise the foundation of our thesis. Herein, we recount our choices research philosophy, -approach, -strategies and -choices, as well as time horizon. Afterwards, we give an account of our quantitative and qualitative methods of data collection and elaborate on the delimitations and credibility of our findings.

The third part contains the empirical findings that we have attained in order to solve our research question. Hereafter, we introduce the reader to the current shape of the global textile and clothing industry and review significant developments that have formed the contemporary nature of the industry. Following this, we will interpret the empirical quantitative and qualitative findings of our study.

The fourth part will encompass the theoretical framework used to identify the obstacles in the global textile and clothing value chain, thereby answering our first sub-question. In order to answer our second sub-

question, we utilize our theoretical framework, once again in conjunction with our findings, to analyze which systemic changes are needed to eradicate the obstacles, as well as to propose a concept that can enable these changes and ultimately support circular value-creation for companies in the textile and clothing industry.

Finally, the fifth part of this thesis, presents our discussion and conclusion will discuss whether our proposed solution can draw on the inherent sources of value creation in a circular economy, which will answer our third sub-question. On that note, the conclusion will provide a summary of our findings, after which we will answer the research question of our thesis, as well as suggest areas for further research.

PART I

2. Literature Review

In order to analyze whether the textile and clothing industry can systematically change production models to accommodate circular business models, it is necessary to first define the terms of circular economy, industrial ecology and industrial symbiosis. A deeper understanding of the concepts will support the analysis of the advantages that such a change enables. By introducing the concepts, unclear perceptions of circular economy, industrial ecology and industrial symbiosis become elucidated, thus achieving a more consistent understanding of the concepts.

The literature review is divided into two main chapters. The first chapter introduces the concept of a circular economy and will be divided into four sub-chapters: i) the concept of circular economy; ii) biological and technical cycles of the circular economy; iii) principles of the circular economy; and iv) sources of value creation within a circular economy. The second chapter introduces industrial ecology. A timeline of the contributions made within industrial ecology are outlined in order to become familiar with the concept. Finally, the last part of the literature review describes the concept of industrial symbiosis. As with industrial ecology, the review of industrial symbiosis will serve as a timeline of the developments made within the field for the reader to become familiar with the concept.

2.1. Circular Economy

The concept of a circular economy is gaining traction in academia, business community and civil society. The increase in its popularity can be explained by the numerous efforts made by the Ellen MacArthur Foundation and others who have been responsible for the first public contributions framing the concept of a circular economy. The shaping of circular economy as a concept has been influenced by distinct schools of thought, such as Cradle-to-Cradle, Performance Economy, Biomimicry, Industrial Ecology, Natural Capitalism, Blue Economy and Regenerative Design (Ellen MacArthur Foundation, 2015).

Opposed to its linear equivalent, a circular economy supports a more careful management of resources which final goal is to eliminate waste that is damaging to the environment. Adopting the definition of a circular economy set forth by the Ellen MacArthur foundation, the circular economy represents a systemic management of resources which industries can utilize to rely on renewable sources of energy, minimize harmful externalities, and eliminate the use of hazardous chemicals; and ultimately eradicate waste

through careful design (Ellen MacArthur Foundation, 2013). A circular economy expands the focus of the economic analysis, moving the unit of analysis to be the industry the organizations pertain to, not the organization nor the product itself. By doing so, not only does a circular economy concentrate on the mechanics of production and consumption of goods and services, it concerns the complete management of material and resource flows that are to be implemented to achieve maximum value.

According to the Ellen MacArthur Foundation, production processes aiming for circular value creation must be formulated considering the concept's core principles (2013): i) design out waste; ii) build resilience through diversity; iii) rely on energy from renewable resources; iv) think in "systems"; and v) waste is food (cf. appendix 5)

Thus, the circular management of materials and resources falls at the intersection of several theories and concepts that have been developed within various disciplines since the 1970s. All emphasizing processes of renewal, reuse and recycling of materials and resources, these theories draw inspiration from biological systems. A pivotal aspect to the circular economy is reverse logistics. Reverse logistics encompasses *"the process of transporting goods from their point of consumption to a consolidation point for the purpose of capturing value or proper disposal"* (Circulate, 2016). In detail, reverse logistics entails the collection of goods, transportation to a central location, and sorting according to ultimate destination, e.g., remanufacturing, refurbishing, reusing or recycling and are to be viewed as an essential method for companies to reduce their waste.

2.1.1. Biological & Technical Cycles

The main objective of a circular economy is to achieve a transformation that enables the economy to restore and regenerate its natural resources. Therefore, the system must be designed to facilitate the modification of technical components used in the manufacturing process of a product today into biological nutrients which consequently are passed on to a succession of other nutrients through separate applications before extracting valuable feedstocks and lastly re-introduce these biological nutrients into the biosphere (Ellen MacArthur Foundation, 2013).

Within the circular management of materials and resources, there are two cycles involved in a circular economy; the biological and technical cycle. For organic materials, food and biologically-based materials (such as cotton or wood) should be designed to return to the system through processes such as biochemical extraction, composting and anaerobic digestion. Thus, the biological cycles are responsible for

the continuous supply of renewable resources for the circular economy, while technical cycles are viewed as fossil fuels, plastics and metals (Ellen MacArthur Foundation, 2013).

2.1.2. Principles of the Circular Economy

The concept of a circular economy rests upon following principles (Ellen MacArthur Foundation, 2013).:

1. *Design out waste:* Circular initiatives aim at redesigning goods and/or services so that waste is eliminated. When doing so, the biological and technical components (nutrients) of a product have the ability to fit within a biological or technical materials cycle. This permits the nutrients to be used for disassembly and refurbishment purposes. Specific to the biological nutrients, the intention is for these to be as pure and non-toxic as possible in order to allow for them to simply composed. However, for technical nutrients, the goal is to design so they can be reused with minimal energy and while ensuring highest quality retention.

2. *Build resilience through diversity*: Modularity, versatility and adaptability are features that need to be at the center of future product design processes. The circular economy views diverse systems with numerous linkages and scales to be more resilient to external shocks than systems built simply for efficiency.

3. *Rely on energy from renewable sources*: Industrial systems should aim to function on renewable sources. Just as materials, energy resources are also getting scarcer with time, and a circular approach should contain measure to utilize environmentally friendly energy resources.

4. *Think in "systems"*. The ability to comprehend how materials and resources influence one another within a whole, and the relationships of the whole to the individual parts, is pivotal. Materials and resources are viewed in the context of their infrastructure and environment. When applying these insights to engineering and business challenges, systems thinking emphasizes flow and connection over time and has the potential to encompass regenerative conditions rather than needing to limit its focus to one or more parts and the short term.

5. *Waste is food:* Waste can be categorized into biological and technical waste. On the biological components side, the ability to reintroduce products and materials back into the biosphere through organic and non-toxic nutrients through restorative loops is at the heart of the idea. On the technical nutrient side, improvements in quality are to be rendered possible by recovery activities such as upcycling processes.

2.1.3 Sources of Value Creation in a Circular Economy

For a given industry, the value that circular solutions can realize differs greatly across products, services, components, or types of materials and resources, and can also depend on the specific geographic location as well as the segment of the value chain. Still, there are four sources which can be applied to create value within a circular set-up (Ellen MacArthur Foundation, 2015);

1. *Power of the inner circle:* This principle refers to keeping the product as close to the market as possible in order to reduce costs realized in the reuse, refurbishment and remanufacturing processes of production. Thus, the faster a product can return to market, the higher the savings on the shares of material, labor, energy and capital embedded in the product and associated externalities such as greenhouse gas (GHG) emissions, water and toxicity.

2. *Power of circling longer:* The ability of the product to circle longer increases the value of the product as keeping products, components, materials and resources in use for a longer period of time makes it possible to prolong its usage and substitute virgin material inflows required to manufacture additional products. Meanwhile, the increase of the life cycle of the product counteracts the dissipation of material out of the economy. Circling a product longer can be done by adding more consecutive cycles or by spending more time within a cycle.

3. *Power of cascaded use and inbound material/product substitution:* The value creation potential of cascaded use lies in: the lower marginal costs of reusing materials as a substitute for virgin material inflows; the reduced costs of labor, energy and material included in the process; and externalities against the marginal costs of bringing the material back into a repurposed use.

4. *Power of pure, non-toxic, or at least easier-to-separate inputs and designs:* To achieve the maximum value a circular economy can provide, each of the above tools requires pure materials and quality of products and components. By doing so, scale economies become effortless aided by the ease of separation, better identification of embedded components, materials and resources. Additionally, and in the reverse processes – such as reduced product damage rates during collection and transportation, lower reconditioning scrap rates, and reduced contamination of material streams during and after collection.

2.2 Industrial Ecology

Similar to the circular economy, the concept of industrial ecology holds several definitions. As a fairly new concept, industrial ecology has emerged in the evolution of environmental management paradigms. At its

earliest stage, definitions revolving around industrial ecology focused on the reuse of residual flows (water and energy waste) from one production process into another process to reduce or, ideally, eliminate polluting waste. More recent definitions have changed to form the interdisciplinary scientific field of industrial ecology which brings scientific ecology, natural and engineering science and territorial economics.

In 1989, the term "industrial ecology" was introduced in an article written by Robert Frosch and Nicholas Gallopoulos. Herein, the concept of industrial ecology was defined as *"The traditional economic model of industrial capacity in which individual manufacturing processes take in raw materials and generate products to be sold plus waste to be disposed should be transformed into a more integrative model: an industrial ecosystem"*. According to Gallopoulos, the function of the industrial ecosystem is to serve as a biological system where recycling and exchanging used goods as well as researching replacement of raw materials to counteract the exhaustion of natural resources is key. Gallopoulos stresses the ability of the environment of an industrial ecosystem to provide an organization with the means to optimize the consumption of energy and materials, minimize waste generation and provide the architecture of the effluents of one production process to serve as the raw materials for another process.

Thus, under this definition, the concept of industrial ecology becomes ecological in two senses: Firstly, industrial ecosystems are considered as non-human "natural" ecosystems as models for industrial activity. Secondly, the term of industrial ecology places human technology in the context of the larger ecosystems that support it, examining the types of resources used in society and the forces that may act to absorb or detoxify wastes. The latter links industrial ecology to questions of carrying capacity and ecological resilience, asking how and to what degree technological society is perturbing or undermining the ecosystems that provide critical services to humanity – here economic systems are viewed in concert with natural ecosystems. The definition introduced by Frosch and Gallopoulos describes the core of the industrial ecology as its ability to develop industrial systems of closed-loop or nearly closed-loop material and energy exchanges through integrating processes. However, many view the definition as too broad. Along the 1990s several attempts made among researchers to answer some of the question that Frosch and Gallopoulos set forth were made.

In the beginning of the 1990s, Tibbs contributed to the field of industrial ecology by relating industrial ecosystem to the global ecosystem. He defines the goal of industrial ecology to be that of designing an industrial infrastructure that is capable to manage activities and adjust its tolerances and characteristics to the natural system *"Industrial ecology involves designing industrial infrastructure as if they were a series of*

interlocking man-made ecosystems interfacing with the natural global ecosystem" (1992, p. 5). Moreover, he points out *"The aim of industrial ecology is to interpret and adapt an understanding of the natural system and apply it to the design of the manmade system, in order to achieve a pattern of industrialization that is not only more efficient, but that is intrinsically adjusted to the tolerances and characteristics of the natural system"* (1992, p. 6). *"Industrial ecology permits an integrated managerial and technological interpretation"* (1992, p. 8). Thus, for Tibbs, the most significant characteristic is to understand the natural ecosystem and design interlocked industrial systems that are fitted to interact within the ecosystem of the earth. Not only did Tibbs contribute to the progress of the definition of the industrial ecology. A crucial contribution was made in 1992, which was the first indication of industrial ecology to be an interdisciplinary study field.

During the same year of 1992, Jelinski et al shaped the concept of the industrial ecology further. For these authors, industrial ecology was to be viewed as an approach. They went onto claim *"Industrial ecology is a new approach to the industrial design of products and processes and the implementation of sustainable manufacturing strategies"* (1992, p. 793). What is more, Jelinski et al had somewhat a different take on the meaning of the industrial ecology. As they defined "*Industrial ecology seeks to optimize the total materials cycle from virgin material to finished material, to component, to product, and to ultimate disposal"* (1992, p. 793). The definition put forward by Jelinski et al. states that the goal of industrial ecology goes beyond optimizing the total materials cycle – the focus is on the whole production process and all its activities as well as the optimization of energy and materials.

Later in 1995, emphasizing its ability to guide industrial practices to develop sustainable practices, Lowe and Evans began to form the concept of industrial ecology as not only a concept but as an emerging framework that offers a theoretical foundation that supports the transformation of industrial systems to match their inputs and outputs to planetary and local carrying capacity. They go on to claim *"Industrial ecology is an emerging framework for environmental management, seeking transformation of the industrial system in order to match its inputs and outputs to planetary and local carrying capacity. A central IE goal is to move from a linear to a closed-loop system in all realms of human production and consumption"* (1995, p.47). In addition to their view of industrial ecology as a framework, they argue that industrial ecology offers a theoretical foundation to support the architecture of sustainable industrial systems *"Industrial ecology offers a theoretical foundation to support the transformation to a sustainable industrial system, operating in this balanced fashion (production and decomposition are well balanced, with nutrients recycling continuously to support the next cycles of production"* (1995, p. 48). From this definition the connection to the concept of a circular economy can be of relation to the industrial ecology via the

nutrients that come to be part of both concept. Moreover, the aim of industrial ecology is to move from linear economic models to closed-loop industrial systems.

Along the same lines, Graedel and Allenby claim: *"Industrial ecology is the means by which humanity can deliberately and rationally approach and maintain sustainability, given continued economic, cultural and technological evolution. The concept requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a systemic view in which one seeks to optimize the total materials cycle from virgin material, to component, to product, to obsolete product, and ultimate disposal. Factors to be optimized include resources, energy and capital" (2003, p. 18)*. Moreover, Graedel and Allenby emphasized the view of industrial ecology as a system that enables firms to alter business practices with the sole goal to achieve sustainability. Still, their takes on the definition of the industrial ecology do not mention the development of nearly closed-loop industrial ecosystems. On the contrary, their focus is on the ability of the system to achieve sustainable practices that fit within the boundaries of the global ecosystem: *"Industrial ecology is the study of technical organisms, their use of resources, their potential environmental impacts, and the ways in which their interactions with the natural world could be restructured to enable global sustainability" (2003, p. 39).*

Following Graedel and Allenby, in 1997, Erkman stresses the interplay between the industrial system and the natural system. Erkman argues: *"Industrial ecology goes further. The idea is first to understand how the industrial system works, how it is regulated, and its interaction with the biosphere; then on the basis of what we know about ecosystems; to determine how it could be restructured to make it with the way natural ecosystems function"* (1997, p. 1). Erkman was able to define the capacity of industrial ecology to facilitate industrial activities for these to be compatible with natural ecosystems. However, Erkman's definition does not go into further detail on how industrial ecology can help design as well as the framing of these activities. Adding to Erkman's contribution, during the same year, Ehrenfeld was able to place the concept of industrial ecology within a wider context. He pointed out: *"Industrial ecology, in its paradigmatic form, would become part of a new evolving Dominant Social Paradigm (DSP) that would include the maintenance of the natural world as a fundamental normative goal"* (1997, p. 1). Until recent years, the Dominant Social Paradigm (DSP) entailed a view that humans are above all other species, the earth provides unlimited resources and progress is an inherent part of human history. Ehrenfeld's contribution was setting industrial ecology within a wider context. Yet, his definition on how industrial ecology can aid environmental sustainability is seen as too broad.

On the contrary, a year after in 1998, Dunn & Steinemann, provided more details and attempted to explain the economic advantages industrial ecology could deliver: "*Industrial ecology symbiotically links industries so that environmental conscious practices can also be profitable. To do this, industrial ecology uses principles of biological ecosystems to optimize the flows and transformation of materials and energy within and across the boundaries of industrial systems"* (1998, p. 661). Similar to the definition of Lowe and Ewans that links the industrial ecology to the circular economic system, Dunn & Steinemann provide details on how industrial systems can become profitable when activities are designed by using principles of biological ecosystem. However, it is not until 2001, that the concepts of biological ecosystems which industrial ecosystems where to aim at were outlined by Korhonen. Korhonen claims: *"In a perfect IE both of the systems (the industrial (sub) system and the (mother) ecosystem) operate according to the same principles of system development: roundput, diversity, locality and gradual change"* (2001, p. 257). With his contribution, Korhonen was able to define the four principles that industrial ecosystems are to follow in order to operate in accordance to the natural ecosystem.

A more notable change happened in 2002, when Seager and Theis claimed *"IE should be defined as a field of study (or branch of science) concerned with the interrelationships of human industrial systems and their environments"* (2002, p. 226). In order to better define the boundaries of the concept of industrial ecology, in 2004, Ehrenfeld contributed to the discourse with a new definition *"…, industrial ecology draws on some vision of an ecological network of interconnected actors exchanging matter and energy. Some see the metaphor as ontological-a-way of extending the bounds of thinking; others see the metaphor as normative, providing prescriptive guides for designing a more sustainable world"* (2004, p. 827). Here, Ehrenfeld stresses the importance of industrial ecology to form symbiotic relationships which goal is to design a more sustainable world.

In 2012, Despeisse et al. attempted to define the concept into further details *"Its (industrial ecology's) key feature lies in the integration of various components of a system to reduce its net resource input as well as pollutant and waste outputs"* (2012, p. 31). Conclusively, the latest contribution to the field of industrial ecology has been that of Leigh and Li in 2015. With their definition they claim: *"IE considers principles of biological ecosystems when designing and redesigning industrial systems to create more efficient interactions both within industrial systems and between industrial systems and natural systems"* (2015).

In the light of the broad range of contributions made to shape the field of industrial ecology, we found that existing definitions can be classified into two categories. The first category involves definitions that focus on industrial ecology to be a tool which can be utilized by companies to accomplish a sustainable management

of resources. Within these definitions, the focal point is the optimal use of resources and materials. The second category involves contributions that define the ability of industrial ecology to be able to design industrial systems so that the activities embedded act in accordance to the natural ecosystem and perform within the boundaries of the ecosystem of the Earth.

Based on the definitions made within the field of industrial ecology, we argue that industrial ecology is *"nearly closed-loop networks of material and resource exchanges which goal is to achieve a balance between production and decomposition and are established by a rich diversity of industrial units, processes and organizations, all contributing to a system with the primary goal to realize economic and environmental value through sustainable practices"*. In our definition, industrial ecology is based on four pillars: i) the systematic repurposing of waste and by-products, which should be seen as potential resources and sources of raw materials to be exploited: ii) losses caused by dispersion must be minimized (energy, CO_2 emissions, etc): iii) the economy must dematerialize through the minimization of total material flows while still providing at least equivalent services, iv) energy must minimize reliance on fossil fuels.

2.2.2 Industrial Symbiosis

Moving from linear business practices to closed-loop material and energy use is the focus of industrial ecology. Many of the contributions made to define the field of industrial ecology revolve around the ability of industrial ecology to offer a systemic approach to achieve sustainability. Industrial activity based on the principles of industrial ecology can greatly reduce harmful impacts associated with pollution and waste disposal, while easing the stress on finite strategic resources. Activities such as reuse, remanufacture, and recycling represent a move in this direction. In order to create a business environment capable of supporting these activities, industrial symbiosis has emerged as the correct infrastructure.

Definitions of the concept of industrial symbiosis were rarely provided prior to 2000, except for one study by Ehrenfeld and Gertler in 1997. In 1997 the authors defined the concept as *"Industrial symbiosis is closely related [with IE] and involves the creation of linkages between firms to raise the efficiency, measured at the scale of the system as a whole, of material and energy flows through the entire cluster of processes"* (1997, p.68).

In 2000, Chertow *"Industrial symbiosis, as part of the emerging field of industrial ecology, demands resolute attention to the flow of materials and energy through local and regional economies"* (2000, p. 313). *"Industrial symbiosis engages traditionally separated industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and/or by-products. The keys to*

industrial symbiosis are collaboration and synergistic possibilities offered by geographic proximity" (2000, p. 314). With this contribution, Chertow raised an important question regarding the boundary between industrial ecology and industrial symbiosis. What is more, physical exchange is mentioned in his definition, but this raises a new critical question which considers the physical exchanges are to be the only concern in industrial symbiosis.

Along the same lines, Jacobsen claims *"As a sub-discipline of industrial ecology, industrial symbiosis is concerned with resource optimization among co-located companies"* (2006, p. 239) *"Within this framework of inter-firm relationships, industrial symbiosis (IS) can be categorized as a concept of collective resource optimization based on by-product exchanges and utility sharing among different co-located facilities"* (2006, p. 240). Obviously, Jacobsen clearly defines the relationship between industrial symbiosis and industrial ecology by defining the sole goal of industrial symbiosis to support the achievement of the industrial ecology goal which is to develop nearly closed-loop industrial ecosystems for improved environmental performance.

Moreover, in 2007, Chertow claimed *"Thus, at least three different entities must be involved in exchanging at least two different resources to be counted as a basic type of industrial symbiosis"* (2007, p. 12). With this definition, Chertow intended to offer a defining characteristic for the concept of industrial symbiosis. However, this definition is rather idiosyncratic. Industrial symbiosis is not to be defined by the feature put forward by Chertow. What defines the industrial symbiosis is the type of exchange which should be a novel exchange supporting the development of a higher closed-loop material exchanges and efficiency of energy cascading. However, the definition provided by Domenech and Davies in 2011 is viewed by many as a great contribution that helped define the concept of industrial symbiosis, *"Within the field of industrial ecology, Industrial Symbiosis (IS) has emerged as a body of exchange structures to facilitate progress to a more eco-efficient industrial system. By establishing a collaborative web of knowledge, material and energy exchanges among different organizational units, IS networks aim to reduce the intake of virgin materials and lower the production of waste by the industrial sector"* (2011, p. 79).

On the contrary, Lombardi and Laybourn had a distinctive take and provided a definition that did not emphasize the need for closed-loop networks to support industrial symbiosis. They claim *"In our experience, IS is not essentially localized waste and by-product exchanges, nor should it be confused with agglomeration economies or industrial clusters where geographic proximity is a necessary condition"* (2012, p. 28) *"…geographic proximity is neither necessary nor sufficient for IS, unlike the concepts of agglomeration economies and industrial clusters, which are explicitly geographically based"* (2012, p. 31) *"IS engages*

diverse organizations in a network to foster eco-innovation and long-term culture change. Creating and sharing through the network yields mutually profitable transactions for novel sourcing of required inputs, value-added destinations for non-product outputs, and improved business and technical processes" (2012, pp. 31-32). These classifications are viewed to add value within the field as they state that geographic proximity is not the condition to apply industrial symbiosis.However, geographical proximity and trust are generally considered important for the development of resource synergies (e.g. Chertow and Ehrenfeld 2012). Also, in the early days of industrial ecology, this belief was largely belief based on conclusions derived from industrial agglomeration economics and the Kalundborg study (1997). Lastly, in 2015 Leigh and Li *"IS applies the ecological metaphor of IE to create a collective approach to firms and industries traditionally viewed as separate entities and considers the entire system with regard to the physical exchanges of materials, energy, water and by-products"* (2015, p. 632).

As mentioned previously, definitions of the industrial symbiosis were rarely provided prior to 2000, except for one study by Ehrenfeld and Gertler in 1997, which defined and explained IS using Kalundborg Symbiosis as the case to explore IE in practice. Early definitions of IS focused on efficiency and optimization of resources or resource flows without emphasizing the eco element or novelty of exchanges based on the establishment of symbiotic relationships. The definition by Domenech and Davies (2011) made a break-through, by the development of the history of industrial symbiosis clearly recognizes that industrial symbiosis is a part of the study field of industrial ecology. However, there are a number of debatable concepts presented in the industrial symbiosis development – this includes geographical proximity, self-organization and the required number of entities and different resources involved in an IS exchange. Drawing from all the contributions previously mentioned, we argue that industrial symbiosis *"is a nearly closed-loop network made of a rich diversity of companies which establish inter-firm linkages to raise an overall systemic industrial efficiency by means of physical exchanges of materials, energy, waste and/or by-products with the purpose to lessen the extraction of virgin materials and mitigate produced industrial waste"*. By proposing our own definition on the concept of industrial symbiosis we tie the most important characteristics and clearly define the purpose of the industrial symbiosis.

3. Theoretical Framework

3.1 Value Chain Defined

The concept of a value chain was first introduced in 1985 by Michael E. Porter, who coined the set of activities that a firm performs to manufacture a good or service as a basic framework for developing a corporate strategy to promote firm competitiveness by directing attention to the entire system of activities involved in producing and consuming a product. Almost a decade after, in an attempt to explain much of the structure of the global economy, in 1994, Gereffi & Korzeniewicz popularized the concept of global commodity chains (GCCs). Since then, the concept of a value chain (VC) has been defined as *"(...) the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use"* (Kaplinsky & Morris, 2001).

To begin with, the numerous concepts vary in their focus on specific products or target markets, in the activity that is emphasized or and in the way in which they have been applied. Nevertheless, in essence, the concepts are very similar and are commonly referred to as the value chain. Fundamental to these concepts is their common goal to explain the complex interactions of companies and processes involved in a given good or service production process.

International production, global trade and investments are now more than ever being organized within global value chains (GVCs). In the context of globalization, the activities that constitute a value chain are often performed through inter-firm linkages on a global scale. Compared to simple value chains which are often located within the same spatial location and in some cases, within the same companies, the nature of global value chains is embedded in their high fragmentation in terms of activities spread between different companies such as first, second and third tier suppliers as well as their geographical spread. Therefore, global value chains can also serve as a pivotal unit of analysis in order to formulate and implement competitive strategies.

3.1.1 Dimensions of the Global Value Chain

The global value chain framework explores four basic dimensions of the global value chain; (i) the input-output structure, which defines the process of transforming raw materials into a final product; (ii) the geographical scope; (iii) the governance structure, which describes how control within the value chain is

exercised; and (iv) the institutional context in which the industry value chain is embedded (Gereffi & Fernandez-Stark, 2011).

The first dimension of input-output structure defines all the value-adding activities and stages of the value chain that serve to bring a product from the design to the end-of-life phase. Of course, the stages and activities vary across industries, nonetheless most often all value chain stages can be divided into following segments; research and design, raw materials, production, distribution and marketing as well as sales and in some cases recycling of products after use (Gereffi & Fernandez-Stark, 2011). The classification of segments within the value chain serves as an illustration of how fragmented the global value chain is in terms of the numerous stages and the vast range of value-adding activities that are performed to the manufacturing of a product.

The second dimension focuses on the geographic location of the value chain. The globalization of industries has been facilitated by globalization and the improvement in transportation and telecommunications infrastructure. An additional factor also shaping the geographical location of value-adding activities is driven by demand for most competitive inputs in each segment of the value chain. Thus, global value chains are globally dispersed and different activities are usually carried out in different parts of the world. For the most part, in the global economy, countries participate in industries by leveraging their competitive advantages in assets. Usually, for developing countries, this specialization concerns the offering of low labor costs and raw materials, while developed countries with highly educated talent are behind research and development and product design.

The third dimension pertains to the governance experienced within the global value chain. Governance analysis allows us to understand how a chain is controlled and coordinated when certain actors in the chain have more power than others. Gereffi and Korzeniewicz defined governance *"as authority and power relationships that determine how financial, material and human resources are allocated and flow within a chain"* (1994).

The fourth and last dimension concerns the institutional context in which the value chain exists. The institutional dimension defines how local, national and international conditions and policies shape each segment of the value chain (Gereffi, 1994). Global value chains are embedded within local economic, social and institutional dynamics.

3.1.2 Governance of Global Value Chains

The theory of global value chain governance can be used to analyze a given value chain from two contrasting points: a top-down and a bottom-up view. The key concept for the top-down view is the "governance" of global value chains, which primary focus in on the companies pertaining to the value chain and the analysis of the organization of international industries.

Governance demonstrates how organizational power actively shapes the distributions of profits and risks in an industry, and simultaneously identifies which participants of the value chain exercise such power. Within a given continuum of value-chain activities, power has to be viewed as the ability of a company to make or shape strategic decisions that affect the configuration and direction of the value-adding activities and thus exert influence and control over other companies in the chain.

For a specific value chain configuration, power can be exercised in two ways. Firstly, power is exerted internally in the value chain by lead firms. Outside the chain, power comes from the institutional environment and consumers. The theory argues that those in possession of industry power actively shape the distribution of profits and risk through their activities.

- Producer-driven chains - power is held by final-product manufacturers; such chains include capital-, technology-, or skill-intensive industries.

- Buyer-driven chains; retailers or marketers of the final products exert the most power through their ability to shape mass consumption via strong brand names. They source their products from a global network of suppliers located in places that combine low costs, satisfactory quality, and proximity to major markets.

The theory of global value chain governance proposed by Gereffi, Humphrey and Sturgeon accounts for the five governance types with different combinations of three key variables: the complexity of information the production of a good or service requires - design and process; the ability to codify or systematize the transfer of knowledge along the chain; and the capabilities of existing suppliers to produce efficiently and reliably. (Gereffi, Humphrey and Sturgeon, 2005).

Firstly, information complexity refers to the intricacy of information and knowledge that must be transferred to ensure a particular transaction can occur. Suppliers working with complicated product and process specifications are more difficult to control and coordinate, which increases switching costs. This effort can be reduced through standardization and codification. Secondly, information codification is the extent to which complex knowledge is converted into industry-wide standards or situation-specific information that can be efficiently transmitted along the chain at a minimal cost. Thirdly, supplier capability

refers to the ability of suppliers to meet all transaction requirements. These may include quantity and quality specifications, on-time delivery, or environmental, labor and safety standards. Suppliers need access to support services such as input supply, equipment maintenance and upgrades, reliable transportation, and certification assistance to develop new capabilities. If affordable and effective services are not available from supporting markets, suppliers will rely more heavily on buyers to meet these needs and vice versa (Gereffi et al., 2005).

The linkages between companies pertaining to a value chain can be defined along a continuum from a market governated chain which is characterized by arm's length relationships, to hierarchical value chains which can be described by their direct ownership of production processes. Between these two opposing extremes one can find three network forms of interfirm governance; modular, relational, and captive. The five-fold typology of GVC governance allows us to understand how the form of governance can change as an industry evolves and matures, and indeed how governance patterns within the industry can vary from one stage or level of the chain to another.

- Market: Within market governance transactions are relatively simple. The information on specifications on goods to be produced is easily transmitted and suppliers are therefore able to make goods with minimal input from buyers. Thus, this type of arm's length transactions require no formal collaboration between the actors, and the cost of switching to a third partner is regarded to be low for both producers and buyers at this type of governance, where the governing mechanism is price.

- Modular: Modular governance exists when complex transactions are relatively easy to codify. Most often, suppliers in modular chains manufacture goods to a customer's specifications and take responsibility for process technology while using generic machinery that is used to spread investments across a wide base of customers. This specific setup allows suppliers to keep switching costs lost and limits transaction-specific investment, even if the relations between buyers and suppliers can be more complex vis-à-vis market governance transactions. Within modular chain, inter-firm linkages rely on information technology and standards for exchanging information flowing back and forth between the parties.

- Relational: During relational governance, buyers and suppliers rely on strong linkages. The strong linkages are the key to provide the adequate infrastructure for complex information to be transmitted and learned. The result of strong and relational inter-firm linkages is frequent interactions and knowledge sharing between parties. Clearly, relational linkages need trust and

mutual dependence which are often achieved through reputation, social and special proximity, and family and ethnic ties. However, in some cases, even if the linkages are relation, lead companies still have the power to exert some level of control over suppliers. Moreover, producers in these chains are more likely to supply goods that concentrate on quality, geographic origin, or unique characteristics. Relational links between companies take time to construct so the costs and difficulties required to switch to a new partner tend to be high.

- Captive: Within captive chains of production, small suppliers are mostly dependent on only one or a few buyers that most often exert a great deal of power. According to the authors, captive networks function through a high degree of monitoring and control by the lead company. Here, power asymmetry in captive networks forces suppliers to operate under conditions set by, and often specific to, conglomerates, leading to strong captive ties and high switching costs for both parties. For the majority of captive chains, the main competences of the larger companies tend to be in areas outside production. Therefore, the wish to help their suppliers improve and upgrade their knowhow and production capabilities does not affect the larger company but benefits the lead firm by increasing the efficiency of its value chain.

- Hierarchy: Hierarchical governance defines chains characterized by only vertical integration and managerial control within lead firms that develop and manufacture products in-house. This production setup is mostly used by companies where product specifications cannot be codified, products are complex, or highly competent suppliers cannot be found.

3.1.3 Upgrading Within the Value Chain

The second view offered by global value chain framework, developed by Gereffi, Humphrey & Schmidt, is the bottom up view. This perspective focuses on the *"strategies used by countries, regions, and other economic stakeholders to maintain or improve their positions in the global economy. Economic upgrading is defined as firms, countries or regions moving to higher value activities in global value chains in order to increase the benefits (e.g. security, profits, value-added capabilities) from participating in global production"* (Gereffi et al, 2005).

According to Gereffi et al, economic upgrading is defined as the process by which the economic actors of the chains, these being firms and workers, are able to move from low to relatively high-value activities in the global value chains (2005). The ability of a party within the value chain to realize economic upgrading relies on its ability to recognize the conditions under which they can climb up the value chain from simple

value adding activities using low-cost and unskilled labor to more complicated and advanced tasks such as "full package" supply and integrated manufacturing. Within the global value chain framework, four types of economic upgrading have been established (Humphrey and Schmitz, 2002); (i) product upgrading or the move towards more sophisticated product lines; (ii) process upgrading which entails an alteration of the production system or the introduction of superior technology to transform inputs into outputs more efficiently; (iii) functional upgrading based on the acquirement of new functions or the abandonment of old ones in order to increase the absolute skill content of the activities; and (iv) chain upgrading in which companies become actors and part of value chains of new but related industries.

3.2 Transaction Cost Economics

Transaction cost economics is one of the most influential theories within organizational and business studies. The first analysis of transaction costs was made by Coase in his paper "The Nature of the Firm" which described transaction costs as simply "the cost of using the price mechanism" (1973). With the use of transaction costs, Coase was able to develop a conceptual framework that could foresee when certain economic tasks would be performed by firms internally, and when they would be performed on the external environment, i.e. the market.

Following the work of Coase, the theory of transaction costs matured with Williamsons identification of the reasoning behind why transaction costs arise and why a particular exchange tends to occur in the market rather than within the company. Williamson describes the determinants of the transaction costs. In terms of both terminology and content, Williamson is one of the strongest proponents of applying the notion of transaction costs economics. According to Williamson, the decision made by companies on whether to internalize or externalize economic activities is concerned with their desire to minimize transaction and production costs. Throughout Williamson's study, he proposes that the vertical boundaries of the firm are dependent on the transaction costs related to buying the good on the market (1981). Thus, when transaction costs are high, it is better for a company to produce the goods, by vertically integrating activities, rather than buying them on the market. On these grounds, a company will seek to expand until the price of doing a task within the firm is the same as that of buying them on the market – by making a transaction.

3.2.1 Critical Assumptions of the Transaction Costs

As developed by Williamson, transaction cost economics is based on the assumptions that human beings are boundedly rational and sometimes display opportunistic behavior. Whether transaction costs for a

particular exchange will be high or low depends on the critical dimensions of bounded rationality and opportunistic behavior pertaining to the individuals that perform such transactions.

Bounded rationality means the capacity of human beings to formulate and solve complex problem is limited and refers to human behavior that is “intendedly rational, but only limited so”. Thus, the capacity to fully evaluate the consequences of all the possible decisions is limited. Bounded rationality will pose a problem only in environments that are characterized by uncertainty/complexity. Therefore, it can be argued that bounded rationality in conjunction with uncertainty and complexity increases the cost of a transaction.

Human beings are not only boundedly rational, but they also sometimes display opportunistic behavior. The description proposed by Williamson describes opportunistic behavior as “self-interest seeking with guile” and as making “self-disbelieved statements” attempting to take advantage of a given situation. Nonetheless, Williamson does not believe that all individuals behave in an opportunistically manner. However, Williamson argues that it is hard to recognize dishonest and opportunistic behavior. As in opportunistic behavior. As we stated previously stated, bounded rationality can lead to difficulties in environments characterized by great uncertainty and complexity. The same occurs for the behavioral assumption of opportunism, in combination with the environmental factor of small number of exchange parties, the mix of the two can lead to problems and can thereby affect whether transaction costs remain high or low for trading partners.

To sum up, adding to the two human factors that can affect whether transaction costs are high or low, are two environmental factors. Bounded rationality in conjunction with uncertainty/complexity as well as opportunism in conjunction with small numbers exchange lead to transaction costs (Williamson, 1981)

3.2.2 Critical Dimensions of Transaction Costs

The determination between different organizational arrangements is to be based on three critical dimensions of transaction costs: asset specificity, frequency, and uncertainty and complexity. Asset specificity describes the level to which a transaction has to be supported by specific exchanges which can only be used in these particular cases. Asset frequency signifies the repeatedness of the transaction between the two exchanging parties. As mentioned in the previous section, uncertainty deals with the complexity that characterizes the environment in which a transaction occurs where the buyer is limited in terms of the information of the purchase, and thus might be faced with higher levels of risk.

According to Williamson, the higher the levels of asset specificity, frequency and uncertainty in the environment, the higher the costs of executing the transaction across a market. Furthermore, transaction cost economics works out of the assumption that contracts often remain incomplete. Negotiating contractual terms and conditions between trading parties is always associated with a cost. In his work, Williamson explains that with higher asset frequency transaction costs associated with specialized governance structures can be justified. Therefore, transactions with high levels of asset specificity, asset frequency and uncertainty and complexity will most likely occur within the vertical boundaries of organizations rather than across markets.

3.2.3 Types of Transaction Costs

For markets, the dominant mode of organization is the price system. In a perfect world, if the behavioral assumptions and environmental factors set forth by Williamson were inexistent, knowledge and individuals would be perfectly honest. Thus, market transaction costs would be zero. When an exchange takes places between a company and an external party, three tasks that must be performed: i) to inform agents of the needs of others; ii) to reward the party for productive behavior; and iii) and to curb bargaining. If considering the example of perfect information and perfectly honest individuals, these tasks would be costlessly performed by prices. Thus, information, enforcement and bargaining costs would be zero. These prices would convey all available information to all interacting parties on the social consequences of their actions and would parties would have the possibility to gain all the information in order to make optimal decisions.

Nonetheless, one must not forget that in practice, markets are hardly ever fully efficient. Therefore, market transaction costs (the sum of information, enforcement and bargaining costs) are always positive. Behavioral dimensions such as bounded rationality and the tendency to opportunism are factors that can explain the existence of transaction costs (Williamson, 1981). Due to bounded rationality, the value of manufactured products will never be perfectly measured. Henceforth, prices will always tend to provide flawed signals, and therefore a price system will not be able to maximize the social product. What is more, parties will generate non-pecuniary externalities and positive measurements costs joined with opportunism will also make it possible for parties to act opportunistically.

In the case of transaction becoming too costly for companies to measure the true value of manufactured goods, and opportunities for bargaining and dishonesty are high, it may prove beneficial for the companies to eradicate these opportunities by aligning the interest of the trading parties by reducing their willingness to act in an opportunistic manner. Such controlling mechanism can be done by breaking the connection

between output and performance. Hence, the price system can be replaced by a mode of organization in which the trading partners no longer profit from their ability to change opportunistic terms of trade, but instead companies may seek a common organization measure where suppliers are rewarded for following previously agreed transaction terms and conditions. These terms and conditions, which can better reflect the overall costs and benefits of the activities, will serve to supersede flawed market prices.

It becomes clear that the overall goal of the organization is to minimize the sum of production and transaction costs. Thus, transaction cost economics can help explain the mode of a transaction - whether the exchange takes place within the market or the internal boundaries of the firm. Adding to the behavioral and environmental factors that shape the dimensions of the transaction costs, there exists a supplementary factor that also shapes the determination of the exchange mode; the atmosphere. According to Williamson, within the theoretical framework of transaction cost economics, the atmosphere factor makes a reference to the local environment in which the transaction takes place. This acknowledgement states that the economic exchange between two parties is embedded in an environmental and institutional context with formal and informal “rules of the game”. As a consequence, Williamson introduces such organizational and informal environment as the atmosphere. The acknowledgement of the importance of such informal rules is pivotal. Nevertheless, the “atmosphere” domain of the theoretical framework of transaction costs theory remains relatively underdeveloped (1981).

Transaction cost economics is mainly concerned with the governance of contractual relations. However, as previously mentioned, one needs to recognize that governance does not operate in isolation. On the one hand, the exchanges occurring within a global value chain are embedded in wider institutional context and within the value chain power can also be exerted by external forces such as the institutional environment. However, on the other hand, individual companies are, to an extent, able to shape transaction costs. For companies with an international focus, performing value-adding activities far away would entail higher production costs than operating domestically due to the suppliers not having the same specialized knowhow and technical capabilities. Nonetheless, companies exploit advantages by outsourcing value-adding activities far away from their key market as production costs remain lower in foreign environments.

All in all, due to its strong capability to explain the vertical boundaries of a company, transaction cost economics is greatly used to explain organizational matters such as governance structures and production functions. Evidence demonstrates that companies which do not utilize transaction cost prior to making strategic decisions are worse off than firms which draw from the theory and ultimately achieve better performance (Yousuf, 2017). What is more, the theory demonstrates that the productivity of a value-adding

activity is a product of both transaction and production costs, and thereby strongly influence the economic efficiency of the activity.

3.3. Cluster Theory

Clustering is the process whereby companies from the same industry gather together in close proximity. Most economists explain clustering as a means for small companies to enjoy some of the economies of scale usually enjoyed by larger firms. There is a growing widespread belief among policy-makers worldwide that clusters can form the basis of a successful economic strategy by supporting regional innovation, encouraging technological spillovers, producing economies of scale and scope and enhancing self-sustaining local economic development. However, definitions on the concept vary greatly. Clusters can be thought of as networks of firms, research institutes and public bodies, which tend to be located in relatively close geographical proximity and whose cross-sectoral linkages generate and renew local competitive advantage.

The literature on industrial clusters is in general chaotic and voluminous. There are no clear schools or branches of cluster theories, and as Bergman and Feser (1999) note, there *"…is no obvious organizational scheme for laying out and drawing connections between relevant theories"*. The main problem is that the theories and scholars have a tendency to borrow parts and bits from other scholar and theories, while never aligning completely within one tradition. As Maskall and Kebir (2007) note *"…one often finds an unfortunate habit of introducing novelty by making slight changes to the explicitly stated or implicitly applied definition of core concepts, or by importing constructs and variables from neighboring schools of thought without any impeding sensitivity towards the inherent theoretical and methodological tensions between what are, in essence, not completely parallel lines of inquiry"* (2007, p. 31). The body of literature thus becomes a bundle of distinctively different, and yet partly similar, theories which are connected in several ways, but with no clear pattern in their connections. Any attempt to characterize them into an organizational scheme is thus problematic, as they will cut across various categories and taxonomies. Hence, there are no widely accepted approaches in the literature, although many authors attempt to classify the theories. For that reason, we acknowledge the need to consolidate the contributions into a relevant theoretical concept. We attempt to do so in the subsequent section by drawing upon contributions in the field of cluster theory that are relevant to our problem area.

3.3.1. Industrial Districts by Marshall

The term of industrial district was used the first time by Alfred Marshall. Early on in 1879, Marshall started arguing that companies gathered in a district can gain a number of advantages that allow them to compete against large companies. Alfred Marshall discovered the existence of industrial districts quite early. His work “Principles of Economics” became one the most dominant textbooks in the social science of economics. In 1890, Marshall attempted to explain the phenomenon of an industry which concentrated in certain locations. Marshall attempted to explain industrial districts by first introducing the reader to its origins and consequently define the advantages the localized industry produces.

According to Marshall, the origins of a localized industry can be explained by two factors; i) physical conditions such as the character of the climate and soil or access by land or water; and ii) the patronage of the lordship. In the early days of industrial localization, Marshall thought that the patronage of a court, ie. the court’s clientele and its characteristic of demands for high quality goods, was of great importance.

In his contribution, one can find six advantages:

1. *Hereditary skill*: Within a concentrated industrial area the mysteries of the trade become no mysteries; but remain in the atmosphere. Special capabilities and knowhow are thus transmitted from one generation to another and become the characteristic qualification of the industrial district.

2. *The growth of subsidiary trades*: Once a number of companies are established within proximity, it is likely that subsidiary companies develop in their neighborhood, making possible the supply of supporting components and materials, organizing its transport, and in many ways conducting to the economy of its product.

3. *The use of highly specialized machinery:* This advantage stems from the high division of labor and specialization that characterizes an industrial district in which there is a large aggregate of production of the same type.

4. *Local market for special skill:* A localized industrial district offers a constant market for specialized skill and knowhow so that employers do not face any challenges when they are looking to hire new employees.

5. *Industrial leadership:* The organization of companies in an industrial district stimulates the companies to continuously improve. Thus, the companies can be able to achieve greater competitive advantage within the industry.

6. *Introduction of novelties into the production process:* Innovative ideas are promptly adopted because they remain in the "atmosphere" of the industrial district, embedded into the local networks.

As explained by Marshall, small and medium companies (SMEs) gathered in a district can compete with large, vertically integrated companies. Specific to SMEs, the competitive strength in an industrial district is provided by external economies that are engendered by the organization of value-adding activities, specialized skill as well as the growth subsidiary industries. Marshall also defines that within industrial districts, companies are able to individually specialize in particular value-adding activities. This definition sets out the systemic nature of an industrial district where each value-adding activity is not to be viewed as an isolated part of production, but as a smaller part of an industrial system solution and comes to form an organism.

While explaining the several advantages that industrial districts engenders, Marshall distinguished between internal and external economies of scale. Internal economies of scale are specific to the company. On the contrary, external economies are mostly achieved through changes that are effectuated outside the firm. Marshall argued that a particular advantage of the industrial district is the realization of the two economies of scale and thereby could explain declining marginal costs of production. While internal economies of scale mostly secure the individual companies competitive advantage, external economies of scale are shared between the companies pertaining to the industrial district and are thus shared between the companies.

To begin with, Marshall was interested in the analysis of uneven distribution of economic activity over space. The topic evolved to the study of the tendency of related companies to locate themselves in close proximity over prolonged periods of time.

Since Marshall's initial reflections on industrial districts were published in 1890, and these thoughts have paved the way for much subsequent thinking. Thus, in the chapter that follows, we will focus on the contributions made by Michael E. Porter on the same topic.

3.3.2 Industrial Cluster – Porter

Initially, Marshall set out to investigate the industrial organizations of nations. Following the same nature, and when appointed by former U.S. President Ronald Reagan, the initial goal of Michael E. Porter was to investigate why some countries had a stronger advantage in some industries vis-à-vis the United States. In a purpose to explain why some nations experienced a competitive advantage over others, Porter developed a concept to capture how the external environment of a company's home base influenced the ability of the company to create value and stay innovative. Porter's main concern was the competitiveness of industries

or companies and the analysis of its constituent factors. When examining the foundations of national competitiveness, Porter argued *"The answer lies in four broad attributes of a nation, attributes that individually and as a system constitute the diamond of national advantage, the playing field that each nation established and operates for its industries"* (1990, p.77). The initial goal was to investigate why some countries had a stronger advantage in some industries vis-à-vis the United States. In a purpose to explain why some nations experienced a competitive advantage over others, Porter developed a concept to capture how the external environment of a company's home base influenced the ability of the company to create value and stay innovative.

This approach is well known as the diamond of business environment qualities. Within Porter's diamond there is a separation made between the factors that form the external business environment. The factors are: (i) conditions of the production in the country, i.e. specialized labor and infrastructure, factors needed to compete within a given industry; (ii) demand conditions, that is the nature of domestic demand for the product or service of the industry; (iii) related and supported industries; the existence or absence within the country of supplier as well as other related industries that are internationally competitive; and (iv) firm strategy, structure and rivalry; the overall conditions that mandating how companies are created, organized and managed, as well as the nature of domestic rivalry.

As a result of the study conducted on the competitiveness of nations, Porter was able to present the concept of clusters as part of the Diamond framework in The Competitive Advantage of Nations. Given the systemic nature of Porter's diamond of national competitiveness, the paradigm underlines the strong connection of geographical clustering of industries supported by vertical and horizontal relationships, with leading international companies within related industries often found in the same city or region of a nation.

Following the arguments proposed by Porter, internationally competitive domestic suppliers create advantages in the downstream industries in several ways. First, they deliver the most cost-effective inputs in an efficient, early, rapid, and sometimes preferential way. Far more significant than mere access to components and machinery, is the advantage that domestic related and supporting industries provide in innovation and upgrading within the clustered production model - and advantage based on close and relational working relationships. Moreover, buyers and suppliers located in close proximity to each other can experience the benefits of short lines of communication as well as the quick and continuous flow of information, and the ongoing exchange of innovative ideas. Thus, companies within a cluster can influence each other's value-adding activities while accelerating the pace of innovation.

Also, according to Porter, when compared with isolated firms located outside a cluster, firms in a cluster are often able to more clearly and rapidly perceive new buyer needs, new technological, operating, or delivery possibilities, as well as the actions and maneuvers of other firms. Benefits flow forward, backward, and horizontally, with people and ideas combining in new ways. More specifically, Porter defines a cluster as *"a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities"*.

In particular, two dimensions are of pivotal importance according to Porter: (i) geographic proximity seems to be the defining element that enables cluster dynamics to evolve - close interactions with local partners are sources of sustainable competitive advantages; (ii) value-creation proximity, according to Porter the strengths of these relations lie in their proximity. Due to the geographic closeness, the activities affect each other's value creation and ultimately this effect opens up the possibility for other actors, such as specialized government agencies, business associations, and other organizations, into the cluster if their activities have a significant impact on the companies' value creation. Thus, Porter argues that organized collaboration can significantly enhance the impact of co-location on performance and notes that many of the cluster dynamics play out even in the absence of such organized joint efforts as an automatic consequence of proximity.

Moreover, as Porter explained later in his analysis: *'The basic unit of analysis for understanding national advantages is the industry. Nations succeed not in isolated industries, however, but in clusters of industries connected through vertical and horizontal relationships. A nation's economy contains a mix of clusters, whose makeup and sources of competitive advantage (or disadvantage) reflect the state of the economy's development'* (1990, p. 73).

3.3.3 Local Innovative Milieu

Our two preceding sections of the theoretical framework of our study have laid emphasis on the ability of clusters to create a beneficial environment for companies. In contrast to the advantages claimed by Marshall and Porter, the Groupe de Recherche Europeen sur les Milieux Innovateurs (GREMI) and Renza describe the cluster as the right tool to provide a local innovative milieu that enhances the response capacity.

The paradigm of the local innovative milieu was first introduced about 15 years ago by GREMI. At the heart of the model, the local innovative milieu is said to increase the innovative performance of small and medium sized companies that operate in rapidly changing markets. Their proposed explanations state that

the existence of companies is not to be seen as separate from their surrounding milieu but rather as a product of it. Hence, a local innovative milieu can be viewed as an incubator of both innovations and innovative companies within a given geographic location.

In addition to the GREMI group, Camagni has also drawn attention to the importance of supplementary aspects such as the benefit of co-location, synergy, personal relations and network. He goes onto claim that all these elements are pivotal as they do not only define the systemic efficiency of the close spatial location of production activities but the determine the response capacity of the individual company (1991). With his definition, Camagni demonstrates that the environment in which a company is placed within is not to be seen as merely a warehouse. On the contrary, the milieu of the company has the capacity to offer endless opportunities for innovation. Therefore, the basic elements of a milieu can also said to be found in the organizational and functional term of the companies; (i) a collection of organizations - each of these organizations (whether businesses, universities, government agencies or otherwise) is to have relative autonomy with respect to the overall common strategic decision-making; (ii) physical elements such as the companies and infrastructure but also non-physical elements (know-how) and institutional elements (iii) an interaction logic which forms part of cooperation, herein the key participants of the milieu should act interdependently to maximize usage of existing resources, and (iv) a learning logic as demonstrated by the capability of the companies to adapt their interactions in response to changes in their economic environment (1991)

3.4 Theoretical Delimitations

As a consequence of the choices regarding the theories in this study, our work is delimited to a certain area. For instance, this study focuses on the specific organization of the value-adding activities pertaining to the production process within the textile and clothing industry, and thus other factors will not be dealt with in greater detail.

The theoretical framework of our study encompasses three different theories; global value chain governance, transaction cost economics and cluster theory. Firstly, we deem global value chain governance to be the appropriate framework that will allow us to understand the current organization of the production activities carried out within the global textile and clothing value chain in a holistic manner. Moreover, with the aim to strengthen our analysis and understand how companies within the global textile and clothing value chain organize their production we have chosen to apply the theory of global value chains governance (Gereffi et al, 2005) Here, we explicate how some firms in the chain set and/or enforce the parameters under which others in the chain operate. The theory of global value chain governance

allows us to examine different characteristics of the textile and clothing value chain by drawing on four different dimensions. For the specific purpose of our study to delve deeper into the organization of the value-adding activities of the industry we chose to concentrate our analysis on the dimensions of input-output structure, geographical scope and governance of the chain while excluding the institutional context dimension due to the fact that, as mentioned when describing the scope of our study, we have chosen to narrow the focus to the organization of the value-adding activities. Secondly, we also view Williamson's transaction cost economics to be the most appropriate theory when analyzing the logic behind whether a company decides to internalize one or more value-added activities or whether the company chooses to outsource it.

Under this theory, the cost incurred in each transaction is at the core in transaction cost theory, as this facilitates decision making for the company. This characteristic of transaction cost theory hits an important fact in the previously presented problem statement for our project. Nonetheless, a clear weakness of using transaction cost theory is that transaction cost theory is concerned only with the transaction as unit of analysis. It only defines one dimension which are the search and information, enforcement and bargaining costs associated with the exchange of a given good and or service between the different participants of the value chain. Thus, the theory is unable to justify other dynamics taking place within the global textile and clothing value chain.

A different theory that could have explained a critical dynamic of the exchanges occurring within the value chain could be Agency Theory. Agency theory is concerned with the dynamic relationship between a principal and its agent. The study could have chosen to explain the difficulties observed along the value chain by applying agency theory. However, due to time restraints we are unable to observe the nature and characteristics of the relationship between the companies pertaining to the global textile and clothing industry. We wish to use the transactions as the basic unit of analysis. Even if we view relationship dynamics between the actors of the value chain as important, our interest remains on the economic costs of these transactions. Lastly, in order to explain the advantages from clustering, we draw from three perspectives on clustering from Alfred Marshall, Michael Porter and GREMi that capture the essence of what we deem the most important advantages of clustered production models.

PART II

4. Scientific Theory

When conducting comprehensive research, one should always be mindful of the philosophy and approach behind it, lest one becomes oblivious to any natural bias or extraneous variables. The following chapter will identify this thesis' research philosophy, research approach, strategies, choices and time horizon.

4.1 Research Philosophy

4.1.1 Realism vs Positivism

The philosophy pervading the research in this thesis can be identified as being predominantly realist in nature. Realism is one of the oldest and most prominent schools of thought within modern science. The earliest inklings of its present form can be traced back to Galileo's (Galileo et. al., 1989) realist approach to the scientific discovery of heliocentrism – that planets orbit their respective sun. While other contemporary scientists and thinkers thought of the discovery as a possible interpretation of the universe, Galileo was adamant that it was the only reality to be accepted, since it was proven by a scientific process.

This approach to the relationship between science and truth – i.e. accepting that there is a reality independent of man's interpretation of it – would end up shaping the philosophy of scientific realism going forward. Advocates (Saunders et al., 1997) of this new way of thinking began preaching the metaphysical aspects of the world: that everything is built up by objects and laws such as matter, atoms, gravity, etc., which can be analyzed empirically, and that they shape the world around us independently of our perception.

Positivism is another centuries-old philosophy with an emphasis on empiricism. However, that is where the similarities with realism end. While realism states that the world is built by objects and laws, it also accepts that these might exist without the knowledge of the researcher. Not so with positivism, where everything has to be quantifiably and empirically proven to be accepted as a part of reality – meaning, if it cannot be perceived, it does not exist. Thus, positivism is not interested in making inferences beyond empirical results and does not seek a higher understanding, like realism does. In short, positivists do not believe in the metaphysical like realists do.

The distinction between realism and positivism is an important one to make in order to understand this thesis' approach to data. What sets the thesis apart from a positivist outlook is that inferences are made from empirical findings to seek a greater understanding of the problem area. Given the subject of the thesis, it would be impossible to come to any conclusions with a strictly positivistic research philosophy. In that aspect, realism is the more ideal approach of the two, since we want to use empirical data to analyze events and phenomena, something positivism does not allow.

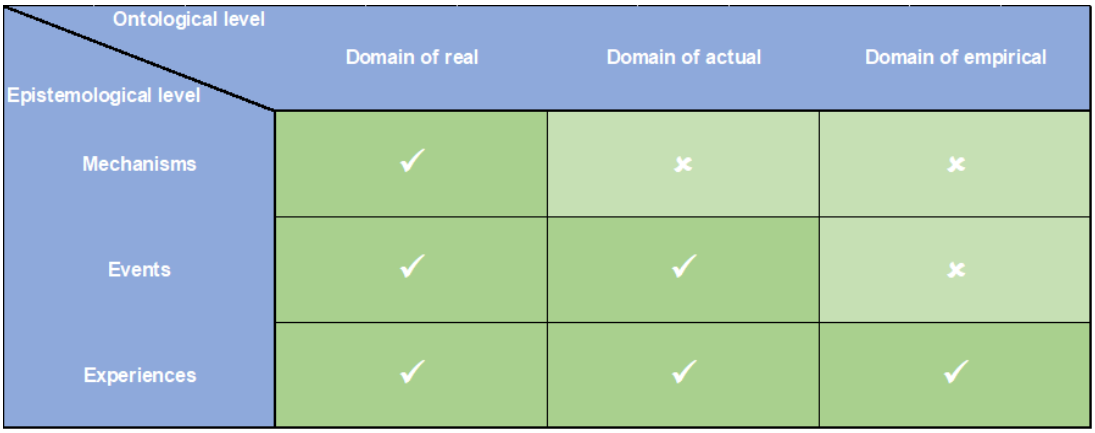
Realism, as with any philosophy, has its detractors. The view anti-realism takes the stance that there is an inherent problem with the relationship between theoretical-observational method to science that realism uses (Duhem, 1906). The method is usually expressed by a researcher establishing theoretical foundation for a hypothesis, which the researcher will then test with observations. But according to anti-realists, theory will always be subject to underdetermination by data, given that an isolated hypothesis cannot be used to derive testable predictions from data, but instead usually needs to be supported by assumptions, delimitations, control variables and other hypotheses, all of which is potentially subject to error as well. The problem of underdetermination and error variables are both huge issues of consideration within the field of statistics.

This thesis acknowledges that due to its broad and complex nature, it might be subject to some of the criticisms mentioned above if a direct realist approach is adopted. Therefore, we will look to a more modern moderation of the realism paradigm to correctly define the research philosophy - a moderation called critical realism.

4.1.2 Critical Realism

Critical realism sprung out of the idea that classic realism, for the reasons mentioned in the previous section, does not hold the necessary distinction between the ontological and epistemological aspects of the world to fully encompass the research process (Bhaskar, 1975). Bhaskar argued that there was indeed a need for a differentiated ontology that allows for scientific practice and experimentation in controlled environments. He argued thus by making the point that purely observational science in the open world would be subject to what he called the epistemic fallacy, ie. scientific error related to the researcher speaking about and making inferences about the 'real world', when he or she is actually only speaking about his or her experience of a real world.

In a sense, critical realism can be broken down into a table like the one below:



Here the relationship between the ontological and epistemological dimensions is visualized: In the purely empirical domain of ontology exists only experiences. According to a positivist, this is the only domain that exists. Going further, the domain of actual acknowledges both experiences and events. A realist would argue that experiences can be used to infer about certain events, ie. the classic observational-theoretical approach. The final level acknowledges that experiences can be used to infer about events, but that mechanisms exist that cannot be experienced or inferred about, but which manipulate the researchers approach to the two former levels.

This is one of the essential ideas of the critical idealist; that unobservable events exist beyond our senses and which can only be inferred about through experiences, *but* that these cannot be trusted to be true without acknowledging that the prevalence and/or interpretation of said events could be biased by underlying mechanisms.

Therefore, due to the less dogmatic view, and more balanced use, of epistemology and ontology of this paradigm, the research philosophy of this thesis can be said lend itself mostly to critical realism.

4.2 Research Approach

Determining the overarching research philosophy is only one step towards having a complete picture of the process. Afterwards, it makes sense to examine which approaches should be utilized when conducting research. There are two such prevalent approaches:

4.2.1 Deduction

The deductive approach is used when having an outset in an established theory that researchers will try to confirm or reject by testing for causal relationships between variables. Robson (2002) breaks down the deductive process into five stages:

- Identifying a hypothesis: Finding an assumption about two or more concepts based in existing theory that can be tested.
- Expressing the hypothesis: Reformulating the assumption into operational variables that adequately represent the concepts, making any testing for relationships possible.
- Testing the hypothesis: The actual test of the relationship between variables using observational data.
- Examine the results: The empirical test can at this point either confirm or reject the hypothesis – or indicate a need for adjustments to the testing model.
- If necessary, adjustments can be made to the model until clear evidence of confirmation or rejection has been found.

The five steps comprise the typical deductive approach, and it is often what people associate with scientific research. However, with the emergence of social sciences in the 20th century (Saunders et al., 1997), deduction became subject to more and more criticism. Researchers in the field of social sciences were wary of resorting to tests of cause-effect type of relationship between variables without considering an understanding of the way in which humans interpreted their social world, not unlike the criticism of realism explained in the previous sub-chapter.

4.2.2 Induction

It was the need for a higher understanding of the specific context of a given phenomenon or event that gave way to the inductive approach. This meant a higher focus on smaller but more detailed samples than what had so far been the norm with the deductive approach. In other words, collection of qualitative data through a variety of methods became the trademark technique within the inductive sphere (Easterby-Smith et al, 2008).

The inductive approach brought something entirely new to the table. Whereas deduction would concern itself with testing of established theory, induction gave researchers a formalized process to build new theory, with the approach lending itself less to establishing a finite truth and more to achieving an understanding of the meanings that humans attach to certain phenomena or events.

4.2.3 Combining Approaches

At this point, it might be easy to establish which sphere the research approach of a given thesis fits into. However, the reality is that a lot of areas of research requires one or more aspects from both of the approaches to gain a complete understanding of the subject issue. Luckily, they are not mutually exclusive (Saunders et al, 1997), and combining the approaches is accepted within scientific research, as long as it is done prudently and only when necessary.

Answering the problem statement of this thesis arguably calls for a combination of deduction and induction; for example, one aim of the paper is to test the assumption that the current global value chain of the textile and clothing industry does not provide optimal conditions for the industry to transition into circular economy. Looking at the description of deduction earlier in this chapter, this aim certainly lends itself to a deductive approach, since we in the first part of our analysis apply our empirical findings to see if they fit with the established theoretical framework, ie. whether the global value chain holds inherent obstacles against circular economy. On the other hand, the thesis also seeks to explore how industrial clustering can help overcome these obstacles. This part of the paper is more exploratory in nature, and fits better within an inductive approach, cf. how induction was described earlier in this sub-chapter.

Choosing to combine approaches brings with it a number of considerations and pitfalls, number one being the time restraints: Deductive research might be faster to complete, however, setting up e.g. a study can be time exhausting if it is complex in nature – whereas induction might involve a shorter period setting up the study, but the data collection itself can take a lot longer time. For example, a deductive approach questionnaire might be complex and hard to set up in a system, but the second it has been distributed to respondents, it more or less takes care of itself with only a bit of maintenance. Meanwhile, an inductive approach set of interviews might be rather simple to design but is more strenuous and protracted to actually conduct.

Another pitfall is the risk related to each approach. An example of risk related to deduction is that a given questionnaire can be subject to participation bias – perhaps the research subject is hostile or controversial in nature to the respondents. Anticipating how willing the respondents might be to participate in a survey is

an important factor when conducting deductive research. Conversely, an induction-related risk might be that a number of time-consuming interviews are set up to explore new areas and possibly build new theory, but no discernible pattern arises that one could form any theory from. This is dangerous, because a researcher might get very far in the process before this becomes clear. Thus, trying to anticipate early in the process whether any patterns are likely to form is important when conductive inductive research.

4.3 Strategies

Having established the overarching philosophy and research approach of the thesis, we will now move on to the strategy for conducting the research.

Saunders et al. (1997) stress that, before settling on a fitting strategy, it can be important to make a distinction of which purpose the study will serve – is it exploratory, descriptive, or explanatory in nature? Exploratory studies look to uncover previously unknown patterns and understand problems on an initial level, while descriptive studies are more static in nature and, as the name suggests, aspire to objectively describe a subject without making any inferences. Finally, explanatory studies examine a certain problem or situation and investigate its relationship with one or more given variables as a way to explain the cause of said problem or situation.

As seen in the field of statistics (Hair et. al., 2014) many studies contain several or all of the above purposes. However, rarely will an explanatory study be conducted without a preliminary exploratory or descriptive study to lay the foundation. For example, a confirmatory factor analysis often needs an exploratory factor analysis to precede it, and only then can a structural equation model be created, which is where the study becomes explanatory.

As established earlier in this chapter, the thesis works from a critical realist point of view and applies a combined deductive-inductive approach to the research. Therefore, it can be surmised that the purpose of the study will be multi-pronged and both exploratory and explanatory in nature, seeing as the thesis will both create a general understanding of the textile and clothing industry and its composition, but also seeks to scientifically explain the shortcomings of the individual companies and the overall industry in terms of transitioning to circular business models.

With the study purpose identified, the optimal research strategy can be picked. Saunders et al. (1997) distinguishes between the following accepted strategies within science:

- *Experiment*: Owes much to natural sciences. Studies relationships between variables through experimental groups and control groups. The focus is on causality and using the control groups to look for and try to eliminate any alternative explanation to the given relationship.

- *Survey*: A classically deductive strategy. Collects quantitative data that can be analyzed using descriptive and inferential statistics. Focus is on fulfilling the requirements for effective statistical analysis, such perfect random sampling, normal distribution, representativeness, etc.

- *Case study*: Can be seen as the opposite of an experiment. Empirically tests a given phenomenon or relationship in a real-world context, ie. a non-controlled environment. Is preferred when researchers aim for an accomplished understanding of context and processes concerning a given relationship.

- *Action research*: Rooted in psychology (Lewin, 1946) and has since been adopted by management researchers. As the name implies, is concerned with research 'in action' instead of 'about action' and involves a bigger focus on collaboration between researchers and the subjects. Is cyclical in nature in the sense that continuous evaluation and corresponding action is at its core.

- *Grounded theory*: Can be seen as theory building (Glaser & Strauss, 1967), though not necessarily exclusively inductive. Data collection starts without formation of any initial theoretical framework, where theory is instead formed along the way and can then be subsequently be tested.

- *Ethnography*: A firmly inductive approach that stems from the field of anthropology. The focus is on describing and explaining the social world of the research subjects, usually through extended participant observation.

- *Archival research*: As indicated by the name, emphasis is on administrative records and documents as a principal source of data. Can be, but is not necessarily, historical in nature. Whether the research is exploratory, descriptive or explanatory in nature, the strategy is fitting when trying to analyze a certain phenomenon or effect over time with outset in the past.

Keeping in mind the combined inductive-deductive approach of the thesis, we consider the case study to be arguably the most fitting strategy. The case study strategy fits very well to what this thesis is trying to achieve – that is, gaining a full understanding of a complex phenomenon in a real-world context. The focus on circular economy in the textile and clothing industry is both a multi-faceted subject and also firmly rooted in the real world.

Yin (2003) distinguishes between four sub-strategies within the realm of case studies upon two axes: Single case vs. multiple case; and holistic vs embedded case. A single case strategy focuses in-depth on a singular case, while a multiple case strategy takes outset in several cases to explore and/or explain a certain subject area. Meanwhile, the holistic case study looks on the organization in question as one unit, while an embedded case study would analyze the organization via several sub-units of measurement. To adequately cover the broad scope of this thesis, an embedded multiple case study is arguably the most fitting cause of action.

4.4 Methodological Choices

At this point, the specifics of the research are beginning to take shape. The next step is to identify the proper methods to conduct the research with and settling on the distribution of quantitative and qualitative data collection techniques. As with the considerations made earlier in this chapter, there are certain distinctions between methods to make before settling on the best fit (Saunders et al., 1997).

The most straightforward method is called mono method and involves only one technique of data collection. With the complex subject area of this thesis, a mono method is arguably not sufficient. Therefore, a multiple methods approach seems more fitting. Under this distinction, there are several subcategories: Multi-method and mixed-methods. Multi-method refers to studies where more than one data collection technique is used, but where all the techniques are still decidedly either quantitative or qualitative in nature. Therefore, multi-method can be subcategorized further into multi-method quantitative study and multi-method qualitative study, respectively. However, as established earlier, this thesis seeks to explore both relationships between variables *and* the context of the world the research subjects operate in, using a combined deductive and inductive approach. Thus, an exclusively quantitative or qualitative approach is not ideal.

Instead, the thesis looks to the mixed-methods category, which is an expression of research conducted with both quantitative and qualitative techniques. Mixed-methods can be further subcategorized into mixed-method research and mixed-model research. The former uses both quantitative and qualitative techniques, but they are not combined in the data management process. The latter, meanwhile, also uses both types of techniques, but *does* combine them in the data management process – e.g. coding qualitative answers to be able to use them quantitatively or converting quantitative data into narrative to be analyzed quantitatively. Of the two, the former is more ideal for the context of this assignment, since it is not the aim to limit the inductive capabilities of the qualitative data collected – or the deductive capabilities of the

quantitative data. This thesis will used mixed-method research with emphasis on both quantitative and qualitative data collection techniques.

4.5 Time Horizon

One of the more important considerations to make is to decide on the time horizon of the study and what best fits the subject area. The general distinction is between cross-sectional and longitudinal studies (Saunders et al., 1997). The cross-sectional studies look at a given phenomenon on a broad scale but at a particular point in time, giving it the characteristics of a 'snapshot'. Meanwhile, longitudinal studies' main forte is the capacity to look at change or development over time. Since the problem statement calls for an exploration of the current state of the textile and clothing industry, the longitudinal study is considered irrelevant. Therefore, the study will be cross-sectional in nature.

To sum up this chapter, the overarching research philosophy has been determined to be critical realism. The ideal approach was found to be a combined deductive-inductive research approach. It was argued that with the study being both exploratory and explanatory in nature, a case study research strategy would be the best fit for the thesis. Furthermore, the optimal choice of methods was determined to be mixed-method research. And the time horizon of the study was argued to be cross-sectional.

5. Data collection and methodology

In the previous chapter, the scientific theory of the thesis was elucidated. This means that the framework for conducting our research is in place. In the following chapter we will cover the concrete data collection techniques that will be used in the thesis.

5.1 Quantitative Data

5.1.1 Choosing Data Collection Technique

One of the principal techniques for collecting quantitative data is the questionnaire. Usually a technique connected to the survey strategy, questionnaires can also be used in experiments and, notably, in case studies such as this thesis (Saunders et al., 1997). Questionnaire is a broad term with multiple definitions, but we choose to adopt deVaus' (2002) definition: *"All techniques of data collection in which each person is asked to respond to the same set of questions in a predetermined order".*

Within the realm of questionnaires, there are numerous types to consider: internet- and intranet-mediated, postal, delivery and collection, telephone, and structured interviews, each with advantages of disadvantages of their own.

When choosing type of questionnaire, some of the primary considerations should be: What kind of respondents are available, and how do they relate to the purpose of the study? In the context of this thesis, the emphasis is on the companies of the textile and clothing industry and their specific challenges regarding a circular transition. Therefore, it is ideal to have the questionnaire revolve around, and address, the companies themselves. This creates a demand for a rather high number of respondents to properly cover the company demographics of the industry. We can for this reason already at this point exclude structured interviews and telephone interviews from our possibilities – it would be too time-exhausting to extract the needed data through those avenues.

CBS offers access to assorted IT licenses, among others a license for Survey-Xact, an online questionnaire program. The program makes it possible to easily design rather complex questionnaires and distribute them on a broad scale. This enables us to go ahead and adopt an internet-mediated type of questionnaire.

5.1.2 Questionnaire Objective

Having now settled on the internet-mediated type of questionnaire, we also want to establish the overall objective of the questionnaire. In this case, it can be identified as two-fold (Saunders, 1997):

- Demographic: Descriptive information about respondents, such as size of business, role in the industry, product portfolio, etc.

- Perceptual: Perceptions on circular economy; experiences from, and behavior in, the industry; opinions of current situation; etc.

In keeping with the deductive aspect of thesis, we wish to be able to make statistical inference from the results of the questionnaire. Thus, it is important to know the demographic traits of the population. This can be hard to determine when the subject is an entire industry, which is a rather loose term, methodologically speaking. Data on how many and who are in which industry is rarely accessible for free and demands that you purchase relatively expensive industry reports from consulting bureaus and the like.

Therefore, to fulfill the first objective of the questionnaire, we need to make an important delimitation: Instead of looking at the entire industry as the population, we look towards the member companies of the Danish trade association Dansk Mode & Tekstil (DM&T). Through a cooperative effort with DM&T, we are able to reach a high number of respondents with our questionnaire without much effort. DM&T helps with the distribution of the questionnaire and makes sure that it reaches the relevant person in each company. To sum up, this cooperation will enable us to achieve the demographic objective, and also reach a higher level of sophistication and robustness in the perceptual objective.

5.1.3 Questionnaire Design

To properly achieve the demographic and perceptual objectives, we categorize our questions according to the framework made by Dillman (2007): Opinion variables, behavioral variables, and attribute variables. Doing so will enable us to easier distinguish between the questions and the overall purposes they serve.

The first section of the questionnaire concerns itself mainly with attribute variables, ie. respondents are providing descriptive information on their companies, how and where they operate, their size, etc. These we use to gain understanding of the industry demographics. The questions are a mix of open-ended and multiple-choice.

Afterwards, the questions are more mixed between behavioral- and opinion variables. The open-ended questions are mostly opinion-based. This is where we collect a lot of the cursory understanding of each respondent's context. This part is exploratory in nature and serves the purpose of informing our qualitative data collection – we learn what the general obstacles of the textile and clothing industry are, so we can delve deeper into said obstacles in the qualitative part of the data collection process.

The behavioral questions are, with a few exceptions, closed-ended in nature. These serve to look at what the businesses have actually implemented, almost as control questions for the opinion-based questions. If a respondent answers that they are very positive towards the idea of circular economy and that they do not experience any obstacles against a transition, checking to see if they have actually taken any concrete measures is a way to show if they are serious in their commitment to a transition.

The closed-ended questions are ordinal in scale, meaning that the respondents are asked to rate, e.g., how thoroughly they have implemented a certain principle or method into their supply chain on a Likert scale (Saunders et al., 1997) from 1 to 5, with 1 denoting 'not at all' and 5 denoting 'Fully implemented'.

5.1.4 Process

The questionnaire was distributed by DM&T and ran from 06-03-2018 to 11-04-2018. Two reminders were sent to during this period to try and bolster the response rate. The reminders were sent at different hours of the day as a way to try and eliminate any participation bias related to when respondents are at work, check their emails, have time off to participate in surveys, etc.

A total of 85 respondents participated in the questionnaire. DM&T has a total of 375 members, which we for the purposes of this questionnaire identify as our population. Therefore, the response rate amounts to 22,67 percent. Of the 85 respondents, 33 completed the questionnaire, while 52 did not go through all the questions before exiting the questionnaire.

5.2. Qualitative Data

5.2.1 Choosing Data Collection Technique

Qualitative data collection can be conducted in several ways, depending on what the study demands. Broadly speaking, the techniques can be divided into observations and interviews. Observation is a typically ethnographic technique which often includes a lot of time-consuming fieldwork, while interviews, though also time-consuming, is arguably a quicker way to gather qualitative data (Saunders et al., 1997). Keeping in mind the broad scope of the thesis, with the chosen strategy of a multiple case study demanding several

sources of data, observation can be ruled out as a possibility. We therefore turn to the interview technique, which can be subcategorized into three types (Saunders et al. 1997):

- Structured interviews: Rather quantitative in nature, this technique uses questionnaires with a standardized set of questions that several subjects are posed with. The difference from its quantitative counterpart is that the questionnaire is usually interviewer-administered and is conducted in person.

- Semi-structured interviews: Compared to structured interviews, these are non-standardized – the interviewer might have a list of themes and general questions to cover, but there is room for on-the-fly follow-up questions and the interview is also somewhat dependent of the flow of conversation.

- Unstructured, or in-depth, interviews: These are completely informal in nature and most often used to explore an area in-depth without little or any prior knowledge. Where the semi-structured interview has a certain point that it wants to get to, this interview form is wholly dependent on the flow of conversation.

In keeping with our case study strategy, we will also be mixing methods in the qualitative research domain. Therefore, our qualitative data sources are spread across several methods, which will be covered below.

5.2.2 Semi-Structured Interviews

The qualitative part of our research serves the purpose of giving context to the what the respondents answered in the questionnaire. This means that we need a qualitative method that enjoys a degree of structure, but still opens up for some in-depth explanation. Easterby-Smith et. al (2008) list three reasons for choosing a non-standardized approach when collecting qualitative data: a large number of questions have to be answered; the questions are complex and/or open-ended; and the order of questioning may vary. These are all reasons that apply to our purpose. Therefore, a non-standardized interview is deemed ideal, and thus we have conducted the following two semi-structured interviews:

Lene Dammand Lund:

To adequately cover the intricacies of our problem area, we want to draw upon the knowledge of an individual with an academic outlook on the entire textile and clothing industry, but still with some degree of real interaction with the industry.

The head of The Royal Danish Academy of Fine Arts Schools of Architecture, Design and Conservation (KADK), Lene Dammand Lund, is an ideal choice. With her overseeing what is taught in design schools, as well as the academy's close cooperation with relevant industries through workshops, case competitions,

etc., Lene Dammand Lund is in possession of a unique insight into the tension field between innovation and production of textiles. With her input, we aim to explore the elusive balance between what can be accomplished from a design innovation perspective and what makes sense financially for the companies to try and undertake.

Lene Dammand Lund is an educated architect, graduating from Aarhus School of Architecture in 1991. She also has an MBA from Copenhagen Business School and has been the head of KADK since 2012. The full interview can be found in appendix X

Lotte Ronan:

The academic insight obtained through the interview with Lene Dammand Lund is arguably not sufficient to gain an understanding of the context of the respondents' answers. We also need the perspective of a company within the textile and clothing industry that experiences whatever obstacles our analysis yields from the quantitative data.

Önling is a micro-sized textile company operating out of Søborg, Denmark. With a heavy focus on sustainability, they produce quality clothes from organic, durable materials with an environmentally responsible supply chain. In other words, Önling fits very well as a case example in our thesis as a company that emphasizes sustainability and is open to circular principles but is impeded by deficiencies of the global value chain to realize any circular value.

As the managing director, Lotte Ronan seems like the most fitting person to represent the company in an interview. A large conglomerate might have a designated operations or sustainability manager, but in this case, Lotte Ronan is arguably the best choice to discuss the company's supply chain. Her full interview can be found in appendix Y

5.2.3 Structured Interviews

As researchers, we were very mindful that reaching out to so many companies of the textile and clothing industry had to our knowledge not been done before but would also open for unique opportunities for data collection. Therefore, we set up the questionnaire to contain not only closed-ended questions for quantitative data collection, but also a number of open-ended questions in the form of text boxes where the respondents could elaborate their answers. We did so for the same reasons that we chose the case study strategy and mixed methods research – we wanted to paint as full and refined a picture as possible of

the textile and clothing industry and the challenges it faces when attempting a transition to circular economy.

These questions are, as elaborated earlier in this sub-chapter, standardized, ie. every respondent answers a uniform set of questions. This allows to direct the flow of qualitative data, which means we can use it to explain the context of each closed-ended answer given. If a certain pattern forms in the analysis of quantitative data, we can look at the open-ended answers to inform and qualify that pattern. The full list of open-ended answers can be found in appendix Z.

5.2.4 Other Sources of Qualitative Data

The writing of this thesis contained a research phase with rather exhaustive data collection, as is demanded when choosing to conduct research with a multiple case study strategy. We have several important sources of qualitative data that were collected somewhat outside of the framework specified earlier in this sub-chapter (Saunders et al., 1997). They will be accounted for below:

CONFERENCE - Taking the Pulse of the Nordic Fashion and Textile Industry:

During the early stages of the thesis writing process, when we were still occupied with scoping out our research area to form a problem statement, Ditte Lysgaard Vind from the consulting bureau The Circular Way recommended that we attended this conference hosted by the Danish Environmental Protection Agency (EPA). The conference was an attempt to sum up the current status of the textile and clothing industry in the context of circular economy and try to work out possible solutions to cultivate a faster and more widespread transition to circular business models. Attended by Nordic EPAs, educational and scientific organizations, trade associations, consulting bureaus, and textile companies, the program contained presentations of circular initiatives by different industry agents, which were then critiqued constructively by the conference attendees. There was also a panel debate and afterwards a workshop where the attendees were divided into groups and had to think up new initiatives and measures to be implemented in the pursuit of facilitating circular transition.

Seeing as we attended the conference early in our thesis process, the aim was purely exploratory on our part; with so many agents of the industry gathered in one place debating exactly the subject of our thesis, we had ample opportunity to gain unique data and also test some of our early assumptions with the attendees.

Furthermore, the conference laid the groundwork for our further research, meaning we gained some valuable contacts and were able to, through assistance from the EPA, attain a full list of the attendees, which we used to send out a trial run of our questionnaire to see how people responded to the questions. This enabled us to make a few vital adjustments to the questionnaire before distributing it through DM&T.

And finally, this was also the place that first contact was established between us and our two respective interviewees, Lene Dammand Lund and Lotte Ronan. Both were in the panel for the debate, where the attendees asked them and two other panel members about their stance on the industry's possibilities for circular value-creation. We got the idea to utilize their knowledge for in-depth interviews, giving us academic and company-level perspectives on the subject issue.

FIELD TRIP - Kalundborg Symbiosis:

Another supremely important component of our data collection process was our field trip to one of the prime examples of fully functioning industry clustering, the so-called Kalundborg Symbiosis, managed by Danish Center for Symbiosis. The thesis being a case study, real-world empirical data like Kalundborg Symbiosis is vital to understanding the subject issue outside of a controlled environment.

As we explored concepts and theories that could account for the value chain-related issues of the textile and clothing industry, we came upon the Kalundborg Symbiosis and saw possibilities for comparison to our problem area. We reached out to them, and they were forthcoming enough to offer us a free tour and presentation of their facilities and business model. This knowledge is vital to our assignment because we can rest our analysis on what is scientifically possible without having to get too technical and straying from the business-oriented nature of the assignment.

At the point of the visit, we had already attended the conference mentioned above and conducted our quantitative and as well as the other qualitative studies. Therefore, we were better equipped to engage in a discussion with our guide, Per Møller, about the advantages of the Symbiosis as well as any shortcomings and pitfalls.

5.3. Secondary Data

Up until now, this chapter has recounted the varying types of data we collect and apply to our thesis. All of it, however, has been primary data, ie. data that we have developed ourselves. The thesis also makes use of a number of secondary data sources that we wish to account for in the following sub-chapter.

5.3.1. Types of Secondary Data

Secondary data can be both qualitative and quantitative in nature. It follows all the same rules as primary data. The difference is that it is a product of a previous data collection process, meaning the researcher has developed the data throughout a given study, but rather uses already collected data to support his primary data. Secondary data can be roughly categorized into three main segments (Saunders et al., 1997):

- Documentary; contains both written and non-written material, such as books, journals, emails, and financial reports, or pictures, video recordings, and audio files.

- Survey; divided into censuses, e.g. of employment or population, continuous surveys, such as labor market trends or employee attitude surveys, or ad hoc surveys, made for specific purposes such as governmental- or academical surveys.

- Multiple source; as the name indicates, draws from several sources of secondary data at once – e.g. a country report or industry statistics. The former being area based, it can contain both newspaper articles and labor market trends, while the latter is time series-based and contains amalgamations of data from different organizations or governmental bodies.

In our thesis, we draw predominantly on multiple source secondary data, since much of the knowledge we seek about the textile and clothing industry and circular economy are compiled in reports and publications, i.e. area-based data. We also use time series-based data such as price development statistics.

5.3.2 Advantages and Disadvantages

The advantages of using secondary data are plentiful. It is a decidedly faster approach to knowledge than primary data. Depending on the situation of the researcher, secondary data can also often be of higher quality than primary data, if it has been collected by institutes, organizations or governments that have the resources to perform exhaustive data collection. It also makes it more suitable for comparative analysis. In our thesis, we use it whenever relevant as a way to support our primary data in external knowledge that has not been biased by our research process.

Higher quality does not necessarily mean more trustworthy. With the use of secondary data comes a number of disadvantages. For example, definitions and categorizations may be rigid and unsuitable for a researcher's specific need. Furthermore, while the quality might seem higher, the researcher has no control over, and less insight into, the validity and reliability of the data. In our thesis, we keep in mind to not

succumb to over-reliance on secondary data; we only rely on data from reputable sources and often, we find support in our primary data to account for these disadvantages.

5.4 Methodological Delimitations and Sources of Error

With a research phase as extended and multi-pronged as the one at the foundation of this thesis, it goes without saying that there are not only a number of delimitations to be made, but also several sources of possible errors that should be accounted for.

5.4.1 Quantitative Data

There were several notable delimitations that we needed to make when designing the questionnaire. Preliminary research showed that there was a lack of encompassing data on the company structure of the textile and clothing industry. When we reached out to DM&T, we had hoped they would be in possession of data on the structure, but they could not help us either.

Therefore, we had to settle with asking a number of questions as attribute variables to gain as much information on our respondents as possible and making sure that there was at least an even spread. While we did achieve said even spread, we can not be sure that the spread matches the distribution of companies in the industry in terms of size, industry role, etc. This limits our statistical tests to only a cursory level of inference, which is also why we use them as indications and only make assumptions that are also supported by qualitative data. The tests should not be treated as causal relationships.

Further to this, because the quantitative research mostly serves exploratory purposes, we have also not attempted any tests of robustness or endogeneity. Therefore, we do not know the path of the correlations we find, a factor which could also potentially have some error attributed to it.

While cooperation with DM&T overall provides us with strong advantages, there are also some pitfalls to be mindful of. For example, the association was not willing to provide the list of relevant people to use as respondents from all their members, since they were wary that the members might feel betrayed that they disclosed personal emails to outside parties. This is a common problem when conducting questionnaires through trade associations, labor unions, etc. Instead, we had to resort to a coded key that automatically creates a new respondent every time it is clicked. Said key was sent our contact within DM&T, who forwarded it relevant people in member businesses along with an invitation text written by us. This method considerable lessens the confidence that the right person has responded, because we can not control who

clicks the coded key and how many times. Therefore, we had to take extra precautions in the questionnaire itself, making sure that each respondent had to fill out their name, position and company.

Even though we account for the complications above, some related sources of error are impossible to avoid. For one, we assume that we reach a broad majority of companies in the textile and clothing industry through DM&T. However, we have to account for inherent response bias. Some companies might not want to participate in our study, e.g. because they disagree that circular economy is an ideal goal, or because it does not interest them. The respondents of questionnaire might be more inclined to give critical answers of the global value chain and positive answers of anything circular economy-related. Additionally, we are left with some uncertainty in terms of who answered the questionnaire. We included text fields where respondents could give their names and the name of their companies to account for this, but several respondents did not fill out these boxes. In theory, there is a possibility that some respondents filled out the questionnaire several times, which could contaminate our data.

Finally, we experienced some questionnaire-specific issues along the way. Bearing in mind the scope and size of our project, we had to make plenty of adjustments during our research phase, as we gained knowledge about our problem area. For example, we had included arguably too many questions in our questionnaire, making it overtly long to complete, especially given our respondents were employees in companies and likely had busy schedules. We could have minimized the number of 'partially completed' respondents if we had shortened the questionnaire. Furthermore, we would have liked to perform some kind of statistical test on our question regarding the spread of the companies' global value chain, but the way we structured the question with multiple choices made it hard to make any inferential analysis from it. We also could have made the tests including company size even more precise, had we changed the question to a ratio scale with precise employee numbers instead of an ordinal scale with intervals.

5.4.2 Qualitative Data

As with the quantitative part of our research, the qualitative part also holds some inherent sources of error, which we will account for.

Our interview with Lene Dammand Lund was extremely helpful and informs a lot of our analysis later in the thesis. However, it should be taken into consideration that she is interviewed due to her capacity as head of the entire KADK, and she is an educated architect. We of course proliferate from that by having her draw parallels to the construction industry, but it should still be mentioned that she of course answers our questions with the mindset of an architect and not a textile designer.

Initially, we wanted to conduct interviews with companies of all sizes to match the spread in our quantitative analysis - ie. one interview with a micro-sized, a small, a medium, and a large company, respectively. However, time constraints limited us to one interview, and we chose to conduct it with Lotte Ronan from Önling, since she fitted our profile of a small or micro-sized company with ambitions of sustainable production, but who also experienced problems with the global value chain.

Furthermore, we were unable to record any audio or video evidence from both our trip to Kalundborg Symbiosis and the conference we attended. We made sure to take extensive notes during both activities but would of course have preferred data files that we could submit to the thesis.

5.4.3. Secondary Data

We use an extensive array of secondary data sources, about which there are considerations that must be made.

Several web sources are used secondarily to support varying points. Most often, these sources are adequately dated, but in the case of Ellen MacArthur Foundation, some information on their website is not dated. According to their content quality policy, we assume that the information is fully updated, but we cannot know for sure.

For our recount of the textile and clothing industry in chapter 6, we make use of only a few sources of secondary data, such as Boston Consulting Group's report "Pulse of the Fashion Industry ", which is mostly focused on the fashion industry, a sub-category under the textile and clothing industry. We choose to use the report, since Boston Consulting group is a rather reputable source. But the chapter could have benefitted from a wider foundation of sources - sadly, data on the industry was scarce.

PART III

6. The Global Textile and Clothing Industry

In the following chapter, we give a short recount of the textile and clothing industry. It will serve as background for the application of our empirical findings and theoretical framework.

Prior to globalization and the development of global value chains, the textile and clothing industry was regulated by agreements such as the Multifiber Arrangement (MFA) and the WTO Agreement on Textiles and Clothing (ATC), both agreements enforced by the World Trade Organization (WTO, formerly known as General Agreement on Tariffs and Trade, or GATT). Even if the purpose of the agreements were distinct, the MFA and ATC agreements are considered to be the main forces shaping global trade within the textile and clothing industry since the 1970s. Introduced in 1974 and working until 1994, the industry was governed by textile and clothing quotas negotiated bilaterally and governed by the rules of the MFA. The MFA provided for the implementation of selective quantitative restrictions when rises in imports of particular products caused, or threatened to cause, serious damage to the industry of the importing country (WTO, 2018). As a result of the MFA, and under its application, textile production processes were much more localized in order to avoid market disruptions. In the very beginning, the function of the MFA was to provide for a temporary solution, however the agreement was renegotiated four times, the latest negotiation taking place in 1991. Nevertheless, through the years of its enforcement, the agreement was viewed by several nations to be a violation of the principles of the multilateral system in various aspects: i) it violated the most-favored nation principle; ii) it applied quantitative restrictions rather than tariffs; iii) it discriminated against developing countries; and iv) it was non-transparent. As a consequence of this developing criticism, the MFA finally expired in 1994. By the end of 1994, and with the establishment of the World Trade Organization (WTO), the MFA was replaced by the Agreement on Textiles and Clothing (WTO, 2018). The termination of the MFA did not comprise the end of quotas on textile and clothing exports from developing countries (Francois et al. 2000). Yet, the ATC was able to shape actions to remove some of the imposed quotas and move towards free trade within the industry. After all, the ATC was meant to steer nations towards the full integration of textiles and clothing industry into a multilateral trading system.

At the present time, the business model of the textile and clothing industry holds a contrasting shape. As opposed to earlier periods, the production scheme defining the value adding activities of the value chain are now no longer carried out within the same firm, nor are they performed within a closed geographic

space, i.e. country or region. For the time being, the textile and clothing value chain is spread around the globe and organizes its value-adding activities around five parts (Gereffi and Memedovic, 2003):

- Raw material supply including: organic and synthetic fibers
- Provision of components, such as yarns and fabrics manufactured by textile companies
- Production networks made up of garments factories, including their domestic and overseas subcontractors
- Export channels established by trade intermediaries
- Marketing networks at the retail level

There exist many differences between the five parts, such as geographical location, labor skills and conditions, and the scale and type of companies, which, of course, affect both the market power and the distribution of profits among the main participants of the value chain. Yet, the fragmented nature of the industry does not solely belong to the value-adding activities of the textile and clothing value chain, it also represents the distribution of global firms in the industry.

As viewed by many, the textile and clothing industry is undergoing various changes. According to McKinsey, the Western hemisphere does no longer represent the global stronghold for sales and the contemporary main sources for growth are countries across Asia-Pacific, Latin America and other regions (McKinsey & Company, 2016). A recent overview of the global textile and clothing industry indicated that developed countries have experienced slow or negative sales growth. What is more, large retailers, among them H&M have expressed their intention to close some of their stores due to a 2% decline of sales in developed countries during the fiscal year of 2017 (Euler Hermes, 2018). But even as H&M close several stores or relocate their business, smaller companies are forced to shut down. This shows how the industry is greatly divided between large retailers (top-players) and SMEs, where top retailers are able to benefit from a winner-takes-all atmosphere (McKinsey, 2016).

One of the weaknesses that the industry has experienced lately is the decreasing length of fashion cycles which is giving rise to sustainability issues. The textile and clothing industry has been one of the major forces shaping the process of industrialization in developing countries such as Bangladesh, China and India among others. Even so, over time, the environmental footprint of its practices in developing countries is hurting these countries. Consumers in developed countries may have benefitted from lower prices for

clothing imported from Third World producers, but those benefits came with costs in the form of labor abuses and environmental impact.

As stated in their most recent report on the global fashion industry, published by the Global Fashion Agenda (GFA) and the Boston Consulting Group (BCG) in 2017, the authors provide evidence of the low performance of the industry in terms of sustainable practices. Scoring 32 out of 100 points, the performance of the industry shows strong performance inequality across segments, value chain stages and impact areas (BCG & GFA, 2017). The Pulse Score is a global and holistic baseline of sustainability performance in the fashion sector. It is based on Sustainable Apparel Coalition's proprietary Higg Index and extends its cope to extrapolate its findings to the entire industry. The Higg index is the most extensive and representative existing transparency measurement tool of the industry. It covers the majority of large companies and was extended to gain a view on currently underrepresented small to medium-sized players.

The differences along the value chain show to be somewhat in the lower end (GFA & BCG, 2017) The end-of-use and raw material stages rate a score of 9 and 17 respectively, while design and development rates 22. However, processing and transportation are the highest at 38 and 41. Not only do performance gaps vary across value chain activities, there are substantial gaps between top and bottom quartile companies in most stages. The gap is biggest in transportation with a 50-point difference and in raw materials and manufacturing which both show a gap of 45 points (BCG & GFA, 2017). Significant gaps are also present across different areas of environmental, social and ethical impact. As pointed out by the report, retailers are more likely to concentrate in areas such as health and safety which are regularly under media spotlight and under regulatory scrutiny (BCG & GFA, 2017). For example, chemical use, which is subject to the EU's REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) legislative framework delivers higher scores for many enterprises. On the contrary, areas such as waste management and water management, which are paid less attention to, rate merely 20 points (GFA & BCG, 2017). What is more, energy shows the largest gap in scores amounting to 58 points.

Considering that the natural resources of the Earth are already weighed down, the predicted increase of the industry's environmental impact will aggravate the situation. The textile and clothing industry will, at its utmost, face several distinct restrictions on one or more of its key factors of production, resulting in the inability of the industry to hold the same growth rate and in the long run prohibiting companies to continue to operate on current linear business models.

For businesses, altering their operations must be a call to action. The report predicts that the fashion industry's profitability is at risk and foresees that companies face a decline in EBIT margins of more than 3%

points if they continue business-as-usual (GFA & BCG, 2017) Thus, developing new business models that are supported by innovative and novel solutions has to be seen as not only a must to ensure profitable economic growth but also as an opportunity to achieve economic growth that is sustainable and enables the protection of current resources.

6.1 Areas of Improvement

While the harm caused by linear practices within the textile and clothing industry is not solely caused by the sub-industry of fashion, the effects of the production organization resting on global value chain configurations across the globe are proving current practices to be unfeasible and an obvious contributor to stress on the natural resources of the Earth. However, linear practices do not only challenge the current business model, they offer room for improvement. According to the "Pulse of the Fashion Industry" businesses are missing out on a value amounting to €160 billion a year until 2030 (2017). Herein, the environmental impacts realized by the industry amount to a total of € 110 billion in terms of water consumption, energy emissions, chemical waste as well as waste creation (GFA & BCG, 2017)

As previously mentioned, a focal point of our study is the stress on natural resources of the global textile and clothing industry. For this reason, the areas of improvement outlined below will only concern those value-adding activities that are, for the most part, not supported by sustainable practices and harm our ecosystem by increasing the negative environmental impact of the industry in terms of water use, CO_2 emissions, use of chemicals, as well as generation and disposal of waste across the different segments of the value chain.

Sustainable performance springs from the initial phase of the global textile and clothing value chain - the design and development phase. During this phase, companies designing as well as developing their products have the ability and opportunity to assess the lifecycle impact of the garment or textiles proposed by them. Thus, the choice of fabrics as well as colors are considered to have a high environmental impact (GFA & BCG, 2017). Prominent fashion designers such as Stella McCartney focus on eco-design and make sustainability their primary tool for designing garments that focus on organic and raw sustainable materials. Accompanied by EDUN, Tome, Eileen Fisher and G-Star Raw, the mentioned retailer brands are creating momentum for the industry to change their business ways. Nevertheless, most companies do not make an environmental assessment prior to the design and development of the products they wish to produce. In order to change this, there are two challenges which need to be addressed. Firstly, is the lack of awareness these brands have of their influence on the environment. Secondly, for the largest part of retailers, focus is

on “design to cost” where the cost of materials is the pivotal force shaping design choices - instead of total environmental impact and other costs such as social costs over the entire value chain.

In resemblance to the design function, the raw materials stage has a disproportionately high impact on sustainability, partly because of the effect it has on recyclability. This stage involves the cultivation and sourcing of base materials which can be divided into two groups, organic and synthetic fibers. Data provided by the Higg Materials Sustainability Index (MSI), a cradle-to-gate material scoring tool by the Sustainable Apparel Coalition (SAC) illustrates that the materials with the highest environmental impact are leather and natural fibers, herein silk, cotton and wool. In terms of negative impacts, these materials show the highest scores measured across all parameters (chemistry, global warming, abiotic resource depletion, water scarcity, eutrophication). Moreover, there are significant difference within one type of material. For example, water use for cotton depends greatly on the method of cultivation (GFA & BCG, 2017)

The fashion industry is experiencing a shift toward greater use of sustainably sourced materials. The share of organic cotton is rising. For industry participants, such change is highly welcomed, as organic cotton has only one quarter of the environmental impact of conventional cotton (GFA & BCG, 2017). Additionally, companies pertaining to the industry are conducting research aimed at the use of natural fibers. As a result, the use of natural fibers has increased over the past years and purchases of organic biodegradable fibers such as hemp, flax, linen and nettle have increased (GFA & BCG, 2017). The use of organic fibers results in a decreased use of water and fertilizers. Moreover, organic fibers show greater resistance to weeds, which means that fewer herbicides are needed (GFA BCG, 2017). However, the challenge in the raw materials stage for organic fibers remains in the finishing processes and thus limit their use within the industry for the time being. In terms of raw materials, new bio-based materials are being introduced. Among others, Lyocell, Tencell and Monocell are of great importance. Not surprisingly, much of the contemporary research conducted within the industry, is focusing on raw materials and much progress is being achieved in the promising areas of new types of fibers such as merino wool-like yarn made of gelatin and leather-like materials based from materials such as pineapple leaves (GFA & BCG, 2017) Considering that most garments on average are used 6 times prior to their disposal (Ellen MacArthur Foundation, 2015), fiber recycling can be used to mitigate much of the environmental footprint of raw materials. However, available technology can result in a 75% loss of value during the garments first life cycle. So far, only polyester and nylon fibers can be recycled (chemically) and produce fibers of as high quality compared to that of virgin materials – and even then, this process is aided by adding by-products. An additional process of recycling, mechanical recycling, works for organic materials, but the process is hard on the fabrics and shreds the materials to a level that leaves individual fabrics much shorter. Therefore, for now, the process of

downcycling reduces the quality of the fabric over time and thus creates a lower-value product over time which eventually ends up in a landfill. While chemical and technical recycling processes are challenged, the mixing of the fibers also constitutes another task to confront during the recycling process. Therefore, at the moment, the economics of recycled materials are unappealing at present. For example, recycled polyester is 10% more expensive compared to virgin materials (GFA & BCG, 2017).

Even so, there is a common consensus among players in the industry that there is great potential in recycling in the long run. This is evidenced by a study showing that savings through the process of recycling amount to 75 % of the energy needed in production and 40 % of the CO_2 emissions compared to using virgin polyester (GFA & BCG, 2017). In order to close the textile and clothing loop, both the technology and economics of recycling need to improve dramatically, ideally with a single standard up to commercialization. The path towards this change depends on technological disruption, industry-wide collaboration and willingness to invest to truly change the industry's way of business.

Following the process of design and the choice of raw materials, the third phase of the value chain includes processing activities such as spinning, weaving and other activities pertaining to the preparation of fabrics. All of these activities hold a significant environmental footprint. For instance, dyeing fabrics alone can require as much as 150 liters of water per kilogram (GFA & BCG, 2017) and the water used for the process is most often discharged unfiltered into waterways. Wastewater pollution is considered one of the major challenges within processing but also in raw materials stages due to the use of nutrients and fertilizers. In regard to the processing phase, limited transparency and traceability is also viewed as a fundamental weakness. Few brands effectively monitor their tier 2 suppliers, partly because of the proliferation of suppliers and the distance from brand operations. This challenge is further complicated, when suppliers in the processing phase, facing high-demand, outsource and subcontract to third-party suppliers unknown to the brand or retailer. In terms of environmental externalities proceeding from processing activities, chemical usage remains the strongest hindrance.

The fourth phase of the production process, the manufacturing stage, involves the activities of cutting, sewing, buttonholing, gluing, welding, and seam taping the fabric as well as some dyeing and finishing such as stonewashing. The environmental footprint of this stage is considered to be low by many. However, water use in garment finishing, share of renewable energy use and energy efficiency of equipment as well as the toxicity of materials used for prints and waste from cut-and-sew samples can negatively affect the environment. Nonetheless, social impact is the main challenge and involves low level of wages, non-compliance to minimum wage and overtime, laws and gender inequality and the inability of workers to

form unions along as issues in the health and safety areas such as issues in building safety, and insufficient length of rest times.

The phase of transportation includes packaging as well as distribution, has clear impacts related to sustainability. Still, compared to the other phases of the textile and clothing industry, the environmental footprint of transportation activities is considered to be much smaller than in other stages (GFA & BCG, 2017). What is more, for all the energy used to move produced garments globally, the transportation stage only constitutes 2% of the environmental footprint of the entire value chain.

During the consumer phase products are introduced in the stores and consumers worldwide are able to purchase produced garments and textiles. Most often, the retail phase of the value chain is omitted in terms of sustainable practices. Still, retail offers the industry with great potential for improving water consumption, energy emissions, chemical waste and waste creation. During this phase, the product is handled, washed, repaired and possibly passed on. Here, the main drivers of the environmental footprint of the fashion industry are the energy and water consumption from washing, as well as energy intensive drying. The type and amount of detergents influence the impact as well. Also important are attitudes about prolonged use. Not long ago, most apparel was carefully looked after, repaired and handed down. With the coming of fast fashion, in the past decade the number of garments purchased by the average consumers has more than doubled. Some consumers treat garments as nearly disposable, throwing them out after a couple of wears. Some companies do not consider the use phase as their responsibility, while others do, but are hindered by the fact that they do not find the solutions to be technologically viable and economically feasible. Nonetheless, brands do have an opportunity to promote awareness here, especially in terms of environmentally friendly washing and the options for reuse – which in turn can boost consumer engagement with their brands.

There is some evolution in terms of brands which have initiatives to educate consumers about responsible use of their products – some do even offer incentives to care and resources to act on their concern (GFA & BCG, 2017). Regulation can also aid in this area. For example, Sweden as halved the tax rate on product repairs (GFA & BCG, 2017) Meanwhile, the sub-industry of rental clothing has emerged, using the web to extend the use of garments beyond one life-cycle period. Companies such as MUD jeans and VIGGA focus on the increase of the product's life-cycle. Yet, there is the additional need for transport and for garments to be washed between rentals. According to a UK survey, more than half of respondents had bought used clothes in the previous year, and a fourth indicated that they would buy more if the choices improved. Moreover, two-thirds said they would consider participating in retailer buy-backs. Research in other EU

countries shows that only 10% of respondents considered buying second-hand in their three most recent purchases (GFA & BCG, 2017).

When it comes to the end of the life cycle of fashion products, different fates are possible. Garments can be put to a different use (second use with a new owner) up- or down-cycled, fully recycled (feeding back to the value chain to close the loop) or then can be disposed of, ending up in landfills or become incinerated. In this stage lies the largest driver for sustainability – preventing garments from ending up as pure waste. The lack of initiatives as well as solutions to address the impacts of this stage show how little attention or lack of technologically viable and economically feasible solutions. Moreover, across the value chain, recycling options are perceived to be the least relevant improvement levers. What is more, companies have expressed a wish to address sustainability elsewhere in the value chain before working on end-of-use. Across the EU 27 nations, only 18% of clothing is reused or recycled, and the global average is 20%. In contrast to glass, plastic, and paper waste, apparel gets little respect at disposal. Indeed, when it comes to packaging, recovery and recycling rates are 98% in Germany and 79% in Belgium.

In 2015, the used-textile market was worth close to €4 billion worldwide (GFA & BCG, 2017). Even so, consumer hesitance toward second-hand clothing in developed countries make it unlikely that the reuse market can develop as a robust, growing part of the fashion industry's value chain without major changes in fashion brands' and consumers' views.

Within the textile and clothing industry, there are firms that offer solutions to achieve circularity. A reverse logistics company, I:CO collects more than 700 tons of used garment in 90 countries for large apparel retailers such as H&M, Puma or Levi's (I:CO, 2018). Their take-back system enables the collection of used garments and shoes at the retailer's point of sale and increases the garments life-cycle through reuse or recycling. I:CO is making it possible for large retailers such as H&M to launch their own sustainable clothing line "Close the Loop" collection and use collected garments to try and negate their environmental impact. Nevertheless, there is a need for new technologies to secure a better management of return flows that are less predictable and more variable.

All in all, the industry has experienced an increase of initiatives aimed towards the transition to a circular business model. Not only did initiatives aimed at sustainable practices concern the corporate social responsibility of retailers, but retailers showed concrete actions to achieve transparency across sourcing and product distribution activities. Thus, even if value-adding activities are to a higher degree being designed with the goal to achieve circular business potential, most companies remain focused on low cost practices.

7. Empirical Findings

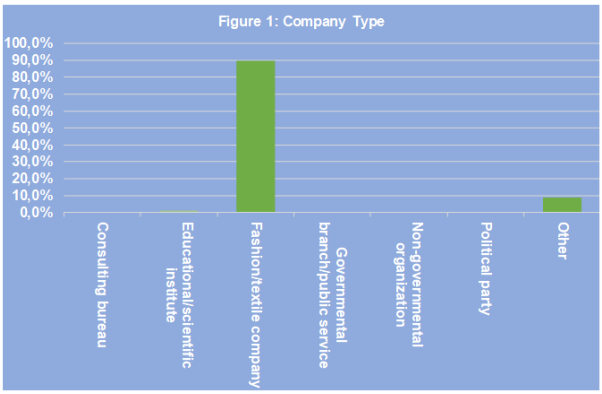
7.1. Quantitative Findings

7.1.1. Descriptive Analysis

To effectively address our research question, we will employ statistical analysis on a number of variables from our data collection. As mentioned in *Questionnaire design*, the data consists of attribute, behavioral- and opinion variables.

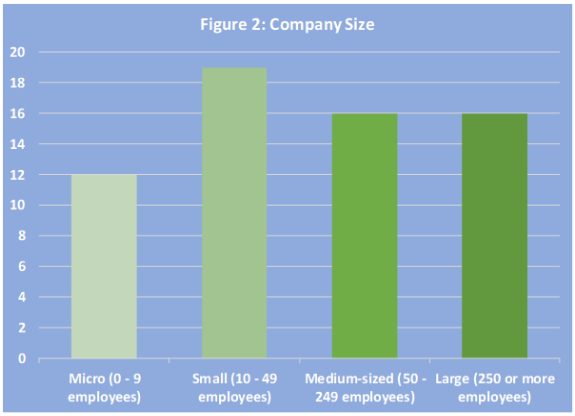
7.1.1.1. Attribute Variables

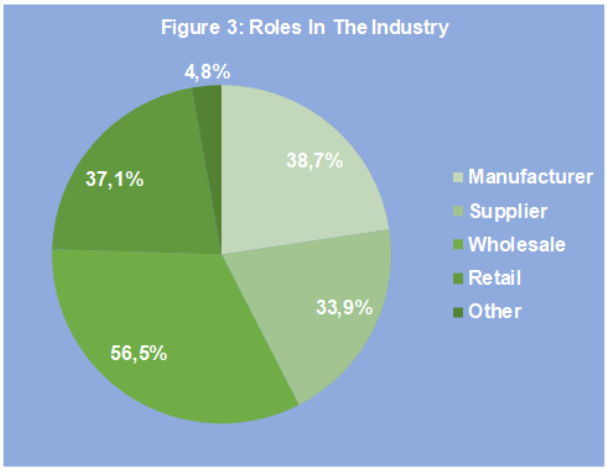
One of the first things to look at when analyzing one's data is to make sure that the sample is representative of the population. No matter how big the sample size is, the sample is useless if it is not representative of the population on key parameters. There are several ways to check this. In the context of this thesis, it would be prudent to look at how the respondents were distributed in terms of roles in the industry, as well as in terms of company size.



Looking at the attributes of the questionnaire respondents, there is a clear pattern in who the participants in our study are.The majority of the respondents are fashion and clothing companies, while the remaining seven respondents under the 'Other' category have answered that they are interior-, carpentry-, and variety retail companies. This fits with information from DM&T that most of their members deals with fashion and clothing. Thus, we assume that the sample is arguably representative of DM&T's population. Bear in mind, this does not equate to being completely representative of the entire industry, since DM&T, being a trade association in a developed country, do not have a lot of members that cover the raw materials, processing and manufacturing stages of the supply chain.

As mentioned, another ideal test of representativeness would be to look at company size, as seen above. As shown in figure 2, the sample is spread rather evenly across all four size segments. There is no definite data on the company structure of the entire industry, which means it is impossible to say whether the sample distribution is representative. However, with a somewhat balanced response rate in each segment, companies of all sizes are covered to at least some extent.



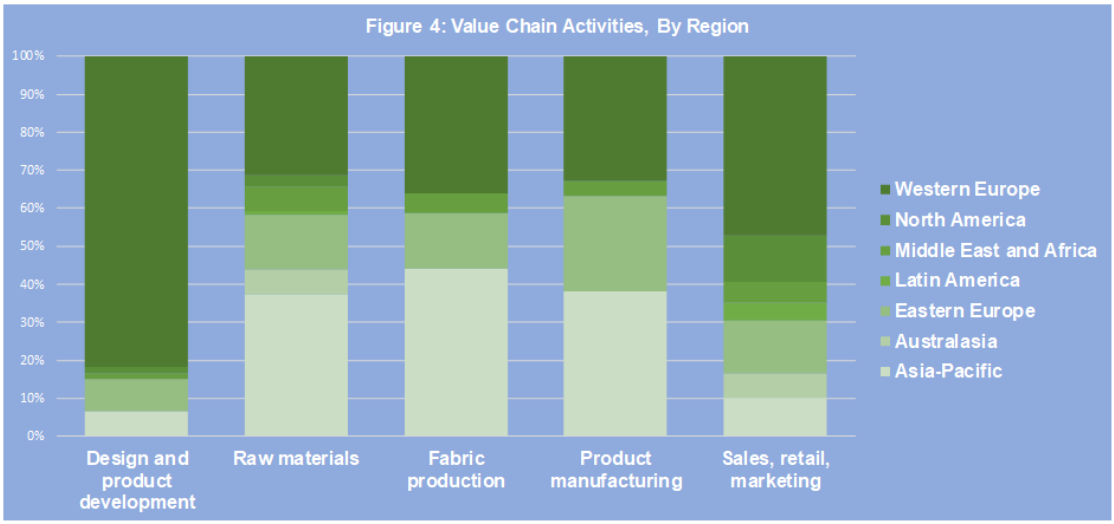


And finally, a third dimension of representativeness to look at would be whether the different components of the industry are represented. Once again, in-depth data for the structure of the industry does not exist, but from the data illustrated in figure 3, we assume with a somewhat balanced spread that all the industry roles are represented in the sample.

7.1.1.2 Behavioral Variables

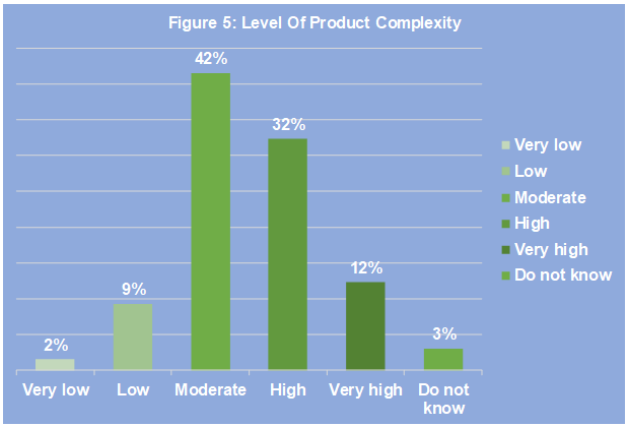
The survey also consists of a number of behavioral variables, which we look at in an attempt to elucidate the way the companies in the textile and clothing industry conduct themselves within the global value chain.

Exploring the textile and clothing industry's production process and how its value-adding activities are distributed geographically is an arguably important aspect of understanding the textile and clothing industry as a whole. We therefore asked the respondents to list where in the world their respective value chain activities are performed. This serves as a way to examine the fragmentation and the geographical spread of the value chain in the textile and clothing industry.



The pattern in figure 4 shows that the design- and product development aspect overwhelmingly takes place in Western Europe, while a large part of the subsequent links in the chain – raw materials, fabric production, and product manufacturing – takes place in Eastern Europe and Asia-Pacific, before most of the sales and marketing once again happens in Western Europe.

Next, we wanted to gain insight into the product-related conduct of the companies in the industry. In the questionnaire, the respondents were asked to account for the complexity of their product portfolio in terms raw materials and basic components, rating it on a 5-point Likert scale from very low to very high. It is apparent from figure 5 that the majority of the respondents characterize their product portfolio as moderately or highly complex.



With the focus of this thesis being on circular economy, it is also important to explore how prioritized some of the circular principles are within the industry. While there are a lot of different aspects to focus on, we chose to focus on two central principles: reverse logistics and cradle-to-cradle. The respondents were asked to first rate on a 5-point Likert scale to which degree they have implemented reverse logistics in their business models, and then on a corresponding scale to which degree they have implemented a cradle-to-cradle approach to their design process.

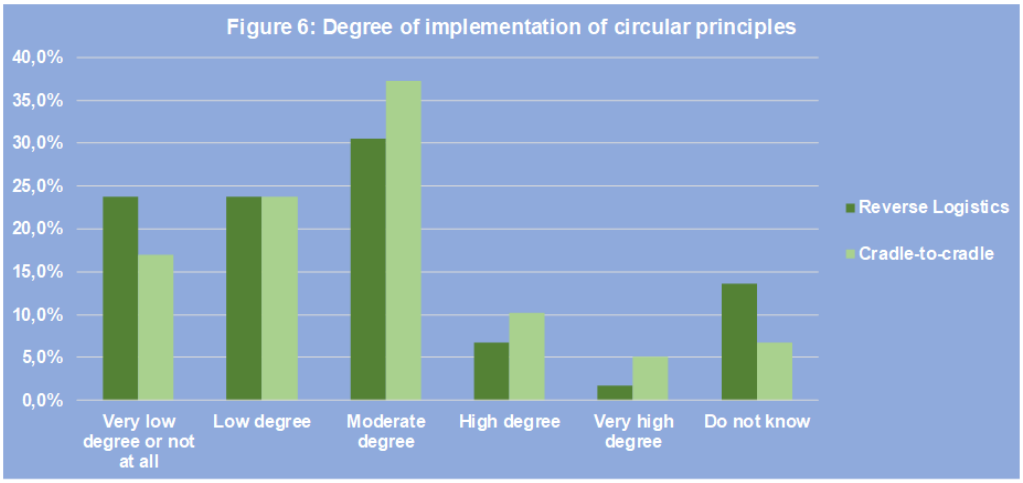
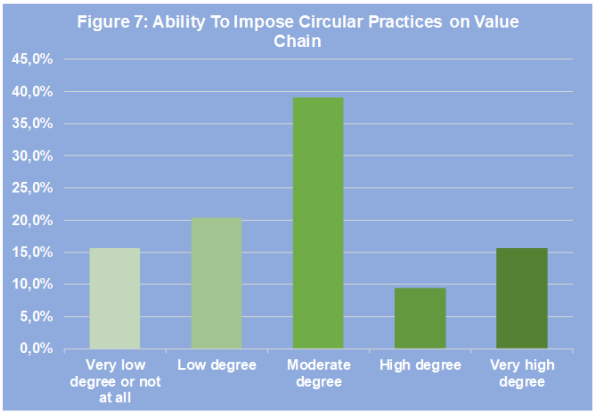


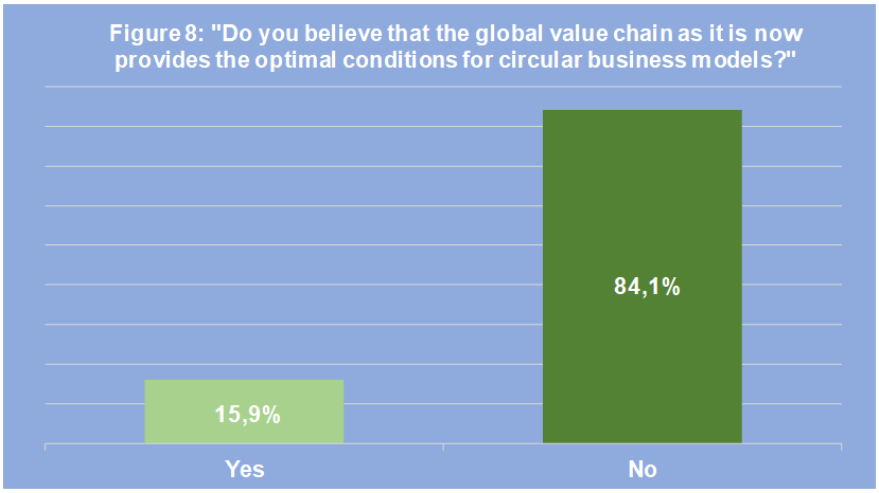
Figure 6 reveals a pattern that the companies in the textile and clothing industry have not quite embraced the core ideas of circular economy into their business models. With reverse logistics and cradle-to-cradle alike, the respondents answered that it had merely been implemented to a low or moderate degree, or even not at all.

7.1.1.3 Opinion Variables

Finally, the questionnaire contained a few opinion variables, include to provide an insight into the industry's perception of itself and the prospects of creating circular value.



Looking at companies from an operational standpoint is one of the key characteristics of this thesis. For that reason, it was important to include an opinion variable that made the respondents consider their value chain and their own role in it: The respondents were asked to rate on a 5-point Likert scale to which degree their company had power to impose any circular practices on their suppliers and business partners in the textile and clothing production process. The results yield a pattern that there is a tendency to have a small or moderate degree of control to impose the needed values on other partners in the supply chain.



Rounding out the account of variables in the study, is a rather simple question for the respondents to answer; we simply wanted to know, whether the industry itself has any conviction in the GVC as the ideal model for creating real circular value. The overwhelming majority answered that this is not the case.

7.1.2. Inferential Analysis

In the previous section, we covered the variables on a descriptive level. These will be used to help identify the obstacles encountered by companies in the textile and clothing industry. However, to understand said obstacles on a deeper level, we will have to resort to analyzing the data inferentially.

From the descriptive analysis we know that the question whether the companies are able to impose circular values on their suppliers and partners yielded a bell-shaped spread of results. In other words, no clear conclusion springs to mind when looking at figure X. Using inferential analysis, we delve a level deeper; in this case, the power to impose values on business partners might be connected to company size. Therefore, we go ahead and test the relationship between company size and the power to impose values.

The variables are both ordinal in nature, meaning they are non-parametric. This is an important distinction, because the values of the variables do not have intrinsic meaning. Compared to, say, having money as value in a variable, where the researchers know that 2 kroner is twice as much as 1 kroner, our 5-point Likert scale is composed of values that we have given meaning. Therefore, a regular linear regression analysis is not ideal. Instead, we use the ordered logistic regression. Its key assumptions is that the data must consist of ordinal variables, which our data does.

Ordered logistic regression — Number of obs = 64
LR chi2(1) = 7.13
Prob > chi2 = 0.0076
Log likelihood = -76.752354 — Pseudo R2 = 0.0444

Towhichdegreeisyourcompany	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Howcanyourcorporationbechar	.5976359	.2286956	2.61	0.009	.1494007	1.045871
/cut1	-.3518874	.5978918			-1.523734	.819959
/cut2	.8881624	.6095257			-.306486	2.082811
/cut3	3.348266	.7500092			1.878275	4.818257

The results of the test can be seen above, with 64 observations for the relationship. The ordered logistic regression is a chi-test, meaning we get a probability of the fit being significant – in this case well below the established alpha of 0,05. Furthermore, we observe in the coefficient analysis that the company size has a z-statistic of 2,62, i.e. a relationship has been observed. To the left, the probability of the z-statistic can be observed as 0,009, also well below alpha. This means that the relationship indicated by the z-statistic is significant to the 99,1st percent. Therefore, we can surmise that there is a strong correlation between how big a company is and how much power they have to impose circular practices on their suppliers and partners.

Next, we want to gain a more in-depth understanding of the industry's degree of implementation of reverse logistics and cradle-to-cradle. As with above, we observe an only slightly tailed spread of answers for both of the principles, and again the aim is to subject them to relationship tests to extract better conclusions. In both instances, it might be interesting to look at the relationship between the complexity of a company's product portfolio and the two principles. The size of a company might also factor in, so for good measure we test both product complexity and company size separately as independent variables against the two principles as dependent variables.

In cases with only one independent variable per two dependent variables, the regular multiple regression analysis is unfit for use. Instead, one might use a multivariate analysis of variance, also called MANOVA, but once again or ordinal variables make a parametric test less suitable. Our third option is to use the

generalized structural equation model, or GSEM, to test the path correlation from first product complexity and then company size and to the two principles.

```
. gsem revlog crad2crad = size

Iteration 0:   log likelihood = -165.15634
Iteration 1:   log likelihood = -165.15634

Generalized structural equation model           Number of obs     =         63

Response       : revlog                         Number of obs     =         56
Family         : Gaussian
Link           : identity

Response       : crad2crad                      Number of obs     =         60
Family         : Gaussian
Link           : identity

Log likelihood = -165.15634
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
revlog						
size	.2806067	.1178867	2.38	0.017	.0495529	.5116605
_cons	1.558505	.3174198	4.91	0.000	.9363735	2.180636
crad2crad						
size	.0745856	.1235697	0.60	0.546	-.1676065	.3167778
_cons	2.387661	.3261553	7.32	0.000	1.748408	3.026914
var(e.revlog)	.9162281	.1731508			.6326182	1.326984
var(e.crad2crad)	1.10551	.2018375			.7729565	1.581138

```
. gsem revlog crad2crad = product

Iteration 0:   log likelihood = -158.20204
Iteration 1:   log likelihood = -158.20204  (backed up)

Generalized structural equation model           Number of obs     =         60

Response       : revlog                         Number of obs     =         56
Family         : Gaussian
Link           : identity

Response       : crad2crad                      Number of obs     =         60
Family         : Gaussian
Link           : identity

Log likelihood = -158.20204
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
revlog						
product	-.2944882	.1277048	-2.31	0.021	-.544785	-.0441914
_cons	3.106299	.448268	6.93	0.000	2.22771	3.984888
crad2crad						
product	.2276029	.1490629	1.53	0.127	-.064555	.5197608
_cons	1.79661	.5217201	3.44	0.001	.7740575	2.819163
var(e.revlog)	.7397075	.1397916			.5107379	1.071327
var(e.crad2crad)	1.070621	.1954678			.7485633	1.53124

In both instances, a pattern can be observed: With a p-value of 0,021 and 0,017, respectively, it seems that both product complexity and company size hold some influence over whether companies attempt implementation of reverse logistics. Conversely, the p-values for product and company size, respectively, on cradle-to-cradle are both far above the alpha of 0,05, which leads to the inference that neither the complexity of products nor the size of the company significantly affects whether companies decides to implement cradle-to-cradle in their design phase.

Finally, we want to make sure that we can trust the results from the final opinion variable. 82,8 percent that they did not believe GVC in its current state gave the optimal conditions to achieve circular value. Fortunately, it calls for a rather simple one-tailed binomial probability test: We simply test whether the observed proportion really is indicative of how many in the industry are unsatisfied with the GVC.

```
. bitest GVCNO == 0.73
```

Variable	N	Observed k	Expected k	Assumed p	Observed p
GVCNO	64	53	46.72	0.73000	0.82813

```
Pr(k >= 53)              = 0.047231  (one-sided test)
Pr(k <= 53)              = 0.976344  (one-sided test)
Pr(k <= 40 or k >= 53) = 0.090380  (two-sided test)
```

As shown above, the probability that the observed k is equal to or below the assumed proportion is 0,047 – just below alpha. We set our assumed proportion to 73 percent after testing for higher proportions, which

gave us p-values above alpha. From this we can surmise that at least 73 percent of the companies in the industry finds the GVC unfit for creating circular value.

7.2 Qualitative Findings

Aside from the findings of our quantitative study, which was described and analyzed in the previous subchapter, we also want to account for what we learned from our qualitative research. The findings are presented chronologically in the order they were collected.

7.2.2. 'Taking the Pulse of the Nordic Fashion and Textile Industry'

The focus of the conference was finding plausible solutions for achieving circularity in the industry. Most of the ideas generated centered around education of companies in the principles of circular economy, developing new avenues of resource efficiency, and raising awareness with consumers.

In the presentations, as well as in the workshops and the general debate, we experienced a distinct lack of emphasis on pragmatic solutions and a certain disconnect between what made sense in theory and what could actually be done from a practical point of view. We attributed this to majority of the conference's attendance being representatives from educational institutes and NGOs, with only a few companies participating.

We contributed to the debate by proposing that the ideas were more closely interlinked with companies' operations and production processes, since our assumption is that education and raising awareness is not sufficient to create actual change from linear to circular business models. This sentiment was moderately received among the majority of the attendants, but most notable the representatives of textile and clothing companies were the ones agreeing with us - one of them, as mentioned, was Lotte Ronan, which was the outset for the interview we later conducted with her.

7.2.1. Interview: Lene Dammand Lund

After we had attended the conference, we approached Lene Dammand Lund via email with the request for an interview, to which she accepted. The interview itself was conducted in her office at KADK and took approximately 45 minutes.

The first part of the interview mostly revolved around the processes of textile production and the obstacles to circular transitions. Lene Dammand Lund provided us with plenty of insight into how students at KADK try to rethink the design phase and constantly work to innovate their approach to the use of textiles. She

also stressed that progress is limited to a certain point because of the complex and inflexible path to materials in the industry.

In light of her participation at the conference we attended, we also discussed how external agents such as governmental bodies are unable to influence any circular transition through regulation. Basically, even if national governments or intergovernmental organizations (IGOs) wanted to push the circular agenda in the textile and clothing industry, they could not do so with any real measures or regulation, since the industry is so fragmented and spread across the globe - and beyond the regulatory sphere of said governments or IGOs. Not only would regulation not have desired effects in terms of sanctions against the major culprits in the textile and clothing industry; it might risk punishing smaller companies that wanted to be circular but were not able to. Therefore, Lene Dammand Lund made the point that change needs to happen at industry- and consumer level, because it is unlikely to happen at governmental or IGO level.

Lene Dammand Lund drew a number of parallels to the construction industry, which she as an architect is also closely familiar with. This industry, which holds many similar characteristics to the textile and clothing industry, has so far done a substantially better job at introducing circularity in its processes. Lene Dammand Lund pointed out that the construction industry boasts a higher degree of small, localized value chains, instead the global, complex variant that textile and clothing companies have to contend with. Exchange of materials and resources happens closer to the involved parties, and buyers and suppliers do not need to engage in transactions from across the globe. This makes it easier to supervise production processes and maintain their circularity as well as optimizing the efficiency and innovation of recyclability in the industry. The full interview can be found in appendix 1.

7.2.2. Interview: Lotte Ronan

As mentioned in chapter 5.2.4, the conference not only gave us the idea to request an interview with Lene Dammand Lund, it also resulted in Lotte Ronan contacting us herself, offering an interview if we were interested, which we were. We accepted, and the interview was conducted at Önling's offices in Søborg. The interview, which can be found in its entirety in appendix 2, took approximately an hour. Lotte Ronan spoke at length about the different processes in the textile production from the perspective of the company, Önling. Specifically, she explained to us how Önling cooperated with suppliers, how a product moved from design phase to market, and the up- and downsides that came with their existing value chain. Lotte Ronan made a point that while the initiatives proposed at the conference were well-intentioned and contained some exciting ideas, there was simply a disconnect between what the attendees found ideal and what could realistically and feasibly be implemented.

While Lotte Ronan stressed that Önling had a healthy cooperative relationship with their suppliers, she also mentioned that they as a company who emphasize sustainability and use of organic materials have no choice but to trust their partners around the globe in terms of certifications and practices - a company of their size simply does not have the capabilities to closely supervise the different processes of their production, when said processes are spread to other continents.

Staying on the topic of production, Lotte Ronan also mentioned that there are simply too many processes involved in making textiles and clothing that inhibits the recyclability of materials. The chemicals necessary to give garments different properties, such as stretch and water-repellence, are too difficult and/or expensive to extract for the idea of recycling said garments to feasibly make sense.

Lotte Ronan's general sentiment towards circular economy was that of optimism towards the potential in the concept, but she maintained that with the current configuration of the industry, she did not see a way to make circular concepts work on a wide scale.

After the interview, we had follow-up correspondence with Lotte Ronan via email, where we requested for her to provide us with concrete numbers for the volume of textiles they procured annually. She could

7.2.3. Kalundborg Symbiosis

Up until our visit to Symbiosis, we had mostly business-oriented insight into our problem area. Since we only had cursory knowledge of the technical processes in a cluster, the visit served the purpose to equip us with a deeper understanding of just how comprehensive changes and advantages we are able to recommend on the back of the technical and biological prowess of a cluster.

Luckily, Per Møller gave us an exhaustive presentation of Kalundborg Symbiosis from historical development, through actors and participants, and all the way to the specific research and experimentation that they conduct.

An important part of the presentation concentrated on the flow of materials between companies. We already knew that the companies shared water and energy, but we were pleasantly surprised to learn that the companies are also extremely synergized in terms of sharing specific materials, including ones that are arguably harder to share than textiles, such as volatile chemicals. Per Møller cited a good example of this effect, where, at one point, the companies in the Symbiosis had a certain volume of waste steam that was not used for anything. One company outside the cluster realized the potential and relocated to the Symbiosis to use the steam. It ended up being the core source of energy for their business instead of first

being a secondary project. According to Per Møller, all companies in the Symbiosis enjoy benefits such as these, regardless of the size of the companies. Furthermore, we were informed that they are already far in the process of developing advanced separation technologies such as rethreading and extraction of chemicals from materials.

The roles within Kalundborg Symbiosis were also established, with Per Møller clarifying that Danish Center for Symbiosis, who manages the cluster, has only a small role in the actual exchanges within the cluster. Their involvement is limited to demanding a small members' fee from each company, so they can conduct monthly workshops, where representatives from the companies can meet and discuss cooperation, synergetic innovation, and exchange of materials. The companies are no subject to any regulation, and they decide their own level of involvement with other companies. The Danish Center for Symbiosis also helps interested companies in screening their operations to find out whether said companies would benefit from symbiotic exchanges with other relevant companies.

7.3 Secondary Findings

As described in 7.3, we use multiple source secondary data throughout the thesis to support our arguments when relevant. Most of this data is used as references and does not need to be covered beyond their mention in the bibliography. However, there are instances where we go a step further and process some of the data into calculations, models, etc. This will be covered in the following sub-chapter.

One of the findings we have made is in regard to water consumption. Data from several reputable online sources (YNFX, TextileLearner) have been cross-referenced to provide us with concrete numbers on the water consumption related to different processes of textile production. The aggregated data can be seen in table 1. The data provided minimum and maximum values, but for the purpose of simplicity, we have taken the mean of the values for each process. The data shows that the water consumption during finishing processes of cotton textile production averages 253,85 litres of water, with dyeing being the by far largest driver for water consumption, equating to 155 litres of water alone. We also make use of price developments in textile fibers. These prices are compiled from industry-specific databases (Federal Reserve Bank of St. Louis, YNFX) and for two textile types, specifically: Cotton and viscose. Due to paywall obstructions, data could only be gathered for three points in time. The

Table 1: Water consumption in textile processes, litres of water per kg cotton	
Sizing	4,35
Desizing	11,75
Scouring	32,5
Bleaching	13,75
Mercerizing	24,5
Dyeing	155
Printing	12
Total	253,85

prices were gathered in Chinese Yuan and afterwards converted to DKK. We also collected data from a textile price index so as to get a picture of the general price developments.

The data in table 2 shows that prices on cotton has drastically increased in two years, while viscose has increased marginally. The textile price index also shows an upwards growth in the given time period.

Table 2: Textile prices			
	apr-16	nov-17	apr-18
Cotton, DKK	7,000	9,114	8,823
Viscose, DKK	13,800	14,748	14,131
Textile index	133,1	136,3	140,9

PART IV

8. Identifying the Obstacles

Part II of this assignment consisted of an account of this thesis' scientific theory as well as our chosen data collection methods. The findings of this thesis' research were recounted and analyzed statistically in Part III. Having done so enables us to unify the qualitative and quantitative data as a way to identify the core obstacles that prevent the companies of the industry to create value from systemic transitions to circular business models. This will be done in the following chapter.

8.1 Empirical Patterns

In accordance with our chosen research methodology, as explained in chapter 4, we use our quantitative data to uncover preliminary patterns. These patterns cannot on their own be used as foundation for our recommendations, so we apply the qualitative data to explore the contexts for these patterns. The open text responses from our questionnaire can be found in appendix 3.

8.1.1 Product-related obstacles

For circular business models to thrive within the textile and clothing industry, the garments must be primed for it. In the inferential analysis, a test was made to see whether the complexity of a product has an effect on a company's decision to implement circular principles such as reverse logistics or cradle-to-cradle. The results showed with a strong negative correlation that the higher the complexity of the product, the less likely a company is to implement reverse logistics. There was no corresponding correlation with cradle-to-cradle.

Seeking to understand the underlying context of this pattern, we turn to the qualitative data. One respondent offers an explanation with the following comment: "*Actually you cannot recycle as much as expected, as the chemicals in garments already used cannot be documented and chem restrictions are tighter every year.*" This corresponds with Lene Dammand Lund's sentiment that: "*[…] the problem is that most products have only one life cycle because of chemicals that make it impossible to rethread the clothes and use it again*," indicating that processes such as dyeing and shaping limit the garments to one life-cycle, since the chemicals make it impossible to rethread the textiles. And as Lotte Ronan states: "*It is almost impossible to avoid chemicals in clothes. Every time a certain property in the garment has to be achieved,*

chemicals are needed." Chemicals are a vital part of modern textile and clothing production, and they are also highly inhibitive of any implementation of circular flow materials.

The consensus among respondents and interviewees also seems to be that the technology to accommodate circular use of complex products is sorely lacking. "*We need access to raw material that has been circulated. I think [the technology for] fabrics have yet to be developed*," one respondent says, which is supported by another respondent: "*(..) the reuse of fibers still needs to be better developed.*" The comments refer to the fact that the technology in its current state only allows rethreading of garments that are completely free of chemicals or external components, and only for products of very simple design without too many cuts or too many different types of textile fibers. This also corresponds well with the earlier quote from Lene Dammand Lund about the limitations of rethreading.

Furthermore, respondents experience hindrances from circular practices from the fact that textiles and clothing are often dirty when recollected, since that is often the reason why users hive away or throw out said product: "*The challenge for our products is that they become dirty, and therefore difficult to handle after use.*" Another respondent supports this issue, saying: "*[…] our products are dirty after [sic] use.*"

After connecting our correlational pattern with qualitative data, we can draw out three main product-related obstacles to achieving a circular transition within the textile and clothing industry:

- **Use of chemicals limits textile recyclability**: Chemicals are ubiquitous in the textile production process, and they make it impractical and expensive to rethread a garment for a repeated or different use.

- **Rethreading technology is lacking**: The available technology only allows for rethreading of relatively simple and chemicals-free products, which is hard to achieve if the product is expected to have shape and colors.

- **Recollected textiles are often too dirty to reuse**: Recollecting textiles at end-of-use often entails that said textiles are dirty, making them either useless or expensive to launder.

8.1.2 Distance-Related Obstacles

One of the main components of our questionnaire was mapping the geographical spread of the industry. The results yielded a clear pattern; the design phase is situated predominantly in Western Europe, while the following stages, raw materials, fabric production, and product manufacturing have a far wider spread,

especially towards Asia-Pacific, but also Eastern Europe. And then the final phase of sales and marketing is once again concentrated around Western Europe and North America.

Looking at the qualitative data to understand the consequences of this distance between links in the chain, we are offered several explanations. One respondent comments: *"[In terms of] Logistics and forecast, it can be tough to predict volume and flow of certain qualities of waste streams in order to ensure a proper input and quality*", and another chimes in with the sentiment: "*Take back systems of used textiles from users, it is too complex and expensive at the moment*". This can be compared to Lotte Ronan's statement: "*We only buy in small volumes to meet specific demands for a collection. Our suppliers take an upcharge of around 35-40 % percent of the order, otherwise it is not financially feasible for them to take such small order from the other side of the globe"*, a picture is formed that the large geographical distance inhibits companies from benefitting from the circular systems such as reverse logistics. Having to send recollected textiles back to manufacturers around the world for rethreading and extraction of chemicals and only then getting to know the volume and quality of textiles to be used is too inflexible for the concept to work. And having it done professionally through take back companies is too expensive an alternative.

Furthermore, transport costs are another point of obstruction that can be drawn from the qualitative data, evidenced by respondent sentiments such as: "*Distances are mostly too far. Also transport costs is a problem*", or as another respondent suggests: "[…] *logistics needs to be improved, fast electricity rail tracks from east to west. Avoid air freight of the shipments best possible. Today, there are not enough vessels for shipment by sea, [which means an] overload of production*". And again, as Lotte Ronan comments: "*It takes several months from design phase and until we get the materials sent from our suppliers, and we are charged with extra import tariffs since our suppliers are based outside the EU*". This indicates that there are substantial raw costs concerned with transporting goods and materials over such great distances which inhibits the incentive for sending any recollected materials back to suppliers.

From the above, we can surmise that there are two main distance-related obstacles within the industry that prohibits circular transition:

- **Difficult to forecast backflow of materials**: The large geographical spread of activities makes supply flows inflexible and unsuitable for circular systems, where volume of certain materials in the backflow needs to be forecasted efficiently for it to work.

- **Transportation costs are too high**: With an overload on few channels of transport over long distances, the costs for transportation are high enough that a circular flow of materials would not be feasible.

8.1.3 Values-Related Obstacles

For an industry-wide circular transition to even be possible, all links of the value chain need to be infused with circular values. In relation to that, we found in the inferential analysis a correlational pattern between company size and power to impose circular values on first, second and third tier suppliers – the smaller the company the less likely it is to be able to control this aspect.

Once again, we explore the qualitative data in an effort to understand the pattern mentioned above. The prime explanation seems to be that: "*[There is] a lack of transparency*," as one respondent puts it. Supporting this argument, another respondent says: "[We need] *more transparency, more advanced techniques to recycle or track the products lifetime*." This statement offers somewhat of an explanation of this lack of transparency: "*Too many suppliers, too traditional thinking in general in the business*," especially when coupled with what Lotte Ronan says: "*We can ask for the correct certifications, but we can never check whether they are living up to standards. It is simply too expensive and time-consuming to travel out to the suppliers and check.*" With such a large network of interchangeable suppliers on the other side of the planet, it is next to impossible to keep track of the practices of each supplier and the suppliers' suppliers.

Another point made in the open-ended answers is that in addition to non-transparency, the industry also suffers from a lack of incentive for the suppliers to adjust to circular values: "*Our supply chain does what we (fashion business) have trained them to do; finding the cheapest options for producing huge quantities - without any demands for responsible production. This situation does not create any circular business or awareness.*" As mentioned earlier in this chapter, Lotte Ronan and her company often experience this lack of incentive, since they are subjected to upcharges from suppliers: "*We often order lyocell as a substitute for cotton in our products, and the upcharge is often included due to the supplier not dealing with lyocell very often, so taking a small order of a specific material like that is not feasible for them."* The industry is so large and so optimized towards mass production that it is hard for singular companies of smaller size to impose any values on said suppliers, because on their own, they are simply not valuable enough as customers to the suppliers. Only larger companies who put in huge orders at a time would have the power to change certain practices with suppliers and partners.

It was mentioned earlier in a quote by Lotte Ronan that checking certifications with suppliers is impractical and expensive. According to the qualitative data, the certifications also pose a different problem: "*[There is] too much administration [sic] in getting approvals for CE-like certificates*", this being the official EU marking for products that meet the requirements necessary to be sold within The European Single Market. "*Fulfilling […] licensing requirements in many different areas takes more than full time,*" another

respondent says, referring to the fact the CE marking demands self-certification, meaning companies spend time and resources on making sure their products meet the requirements and fill out an official declaration to put on the product. This process would have to be replicated with recycled products, making it impractical compared to just making new products.

Summing up, we have identified the following three product-related issues that obstruct any attempt from companies in the industry to transition to circular business models:

- **Lack of value chain transparency**: With the industry's exhaustive network of suppliers, smaller companies are hard-pressed to have any real insight in where and how their suppliers actually conduct themselves.

- **Lack of incentive for suppliers**: The industry has optimized the production on a huge scale for the world-wide demand for textiles, but at the same time it has yet to find a way to make it attractive for suppliers to accommodate any circular principles.

- **Slow and impractical certification process**: The time and resources consumed by getting products certified leaves companies less inclined to attempt implementation of circularity.

8.2 Theoretical Support

Having identified eight patterns in our empirical data, we will now compare these patterns and their contexts with aspects of our theoretical framework and see if our analyzed findings hold up to theoretical scrutiny. This will ensure that our identification of obstacles is as informed and methodologically sound as possible.

Considering the obstacles from a theoretical point of view we clearly see that there are two main reasons why firms within the textile and clothing industry are faced with product-, transport-, as well as value-related costs. On the one hand, the great spread of geographical distance between the value-adding activities in the chain aggravates the potential benefits of activities aimed to create circular economic value such as textile reuse, repurpose and recycling as well as the incentive for the companies to prioritize the return of backflow materials.

The reason for this specific organization can be explained by three key variables proposed by Gereffi:

- The complexity of information the production of the garment requires.

- The ability to codify or materialize the transfer of knowledge between links along the value chain.
- The capabilities of suppliers to produce efficiently and reliably.

The complexity of information is the difficulty of the message or instruction that must be delivered to suppliers in order for an exchange of materials to occur (Gereffi et al, 2005). Hereafter, the ability to codify the message has to do with the ability to convert the knowledge into industry-wide standard, that is information specific knowledge that is transmitted along the textile and clothing value chain with minimal cost. Lastly, the third element revolves around the competence of suppliers to meet product requirements set by textile and clothing retailers, such as quantity and quality specification, on-time delivery or environmental, labor and safety standards.

According to Gereffi, this variable triad help us understand the type of organization that characterizes a given chain. Using the lenses of this variable triad, we observe that transactions made at the stage of the design process are much more complicated than the rest of the processes performed in the remaining stages of the chain. Thus, as our questionnaire reveals design activities remain close to textile and clothing retailers due to the high complexity of information to be delivered to suppliers if the activity was to be outsource. At the same time, suppliers lack the ability to codify and transfer this knowledge along the chain as well as the capability to absorb the knowledge received and be able to perform accordingly. As the complexity of the value adding activities being performed along the chain decreases, the geographical spread increases. This geographical pattern is also supported by our quantitative analysis. Our survey showed that, contrary to the design phase, which for the most part is located within the Western hemisphere, activities such as raw materials, fabric production and product manufacturing are performed in the areas of Asia-Pacific and Eastern Europe. Indeed, as the value adding activities to be performed increase in complexity, we observe that the spatial location of them become closer to the West and North America, where textile and clothing retailers or companies used for outsourcing purposes possess higher capabilities for taking in knowledge and acting on it. In other words, the organization and distribution of the value adding activities of the textile and clothing industry follow Gereffi's principle for the exertion of organization control on suppliers. This means that the more complex the transaction, the harder it is to codify the transaction, and the lower capabilities the supplier has, the more organizational proximity is needed to ensure suppliers act in accordance with their buyers and fulfill product requirements.

On the other hand, according to global value chain governance framework, modes of governance can change from one phase of the stage of the value chain to another (Gereffi et al, 2005). Modes of governance are exercised by the lead firms who are able to shape the distribution of profits and risk

through their activities. Specific to the textile and clothing industry, the nature of the activities can be explained by the typology of a buyer-driven chain. Here, it is evident that the production organization used to manufacture garments is highly dictated by large conglomerates of the industry. The global textile and clothing industry is the quintessential example of an industry where buyer-driven power is exerted by lead firms in the value chain and impose the "rules of the game" on smaller participants (SMEs). Large retailers and strong names are able to shape mass consumption and as a result, they source their products from a global network of suppliers located in countries offering low-cost labor, satisfactory quality, and in some instances, proximity to major markets (Gereffi et al, 2005). Therefore, large textile and clothing companies that develop and sell brand-name products have control over how, when, and where the different manufacturing activities will take place, and how much profit is created at each stage, controlling the distribution of the value-adding activities at all times.

Our quantitative data showed no pattern between the size of the firm and the firm's ability to design sustainable garments. As we did not find any correlation between the two variables, we conclude that any challenges firms encounter at this stage are not related to the firm's size. This lack of a pattern can be explained by the geographic proximity of the activity to its owner, here the greatest part of retailers own their design process so smaller companies are not subject to the same obstacles that result from outsourcing practices to suppliers in Bangladesh, India among others - obstacles that would arise from information complexity, codification and supplier capability deficiencies. Contrary to the design phase, our analysis shows that smaller companies begin to face difficulties with imposing values in process and manufacturing stages. This is due to the lack of first and second tier suppliers to understand information given by retailers, materialize the know-how received and subsequently lack the capacity to act according to the received instructions and therefore are unable supply products or services that meet such requirements. During these stages, the initiatives to bear the industrial transition towards a circular economic model are restrained by factors such as suppliers lack knowhow and technology.

Moreover, the relations between textile and clothing retailers and suppliers within these segments of the textile and clothing value chain are either captive or modular in nature (Gereffi & Frederick, 2010). Captive relationships are characterized by the lead firm's ability to govern over small suppliers which are dependent on them and operate under a high degree of monitoring and control by the lead firm. Within modularly governed chains complex transactions are easy to codify.

In order to achieve greater productivity based on a circular economic model, textile and clothing retailers need to improve suppliers' ability by upgrading their capabilities. Economic upgrading can take the form of

product, process, functional and chain upgrading. The global value chain framework offers a bottom-up view from which different economic upgrading methods can be employed for suppliers and other participants of the chain to alter the governance mode and alter their position in the global economy. Product upgrading, process upgrading, functional upgrading and chain upgrading are the different ways of companies to climb the value chain.

In the stages of processing and manufacturing, workers need only to know how to operate sewing machines and cutting and pressing equipment. Yet, the skills required to operate the machinery can be extensive. However, educational requirements to operate them remain very low. Thus, first and second tier suppliers usually only ask for their workers to demonstrate a minimal level of reading, writing, and mathematics. Howbeit, if the purpose of textile and clothing retailers is to have full-package suppliers (OEM), for suppliers to reach this goal they are required more highly trained workers which need a higher level of knowledge to fulfill production requirements. Following the same nature, and having the same characteristics, upgrading capabilities of suppliers to become original design manufacturers and sand original brand manufacturers also require more advanced skills, sometimes related to marketing and consumer research. To facilitate the shift from assembly to full-package production, it is advantageous for companies to be able to train their workers and staff in-house.

8.3. Summary

Our quantitative and qualitative data shows how the majority of textile and clothing companies are concerned with the production and transaction costs of the exchanges carried out to perform each value-adding activity - and the profit that results from these. Even if their goal is to produce sustainable garments and attempt to be circular and prolong the life cycle of the garments - the complications to ensure the profitability of these activities are manifold, and thus, make a circular business model questionable and hard to execute. Governance structures in global value chains evolve in conjunction with the forces that shape industry structures. Yet, the current environment of the industry's "race to the bottom" sourcing strategy does not present any favorable conditions for firms to achieve circularity.

9. Closing the Textile Loop

9.1 Circular Economy & Industrial Ecology

To effectively eradicate the obstacles identified in the previous chapter, we turn to the concept of industrial ecology. Similar to circular economy, an industrial ecological approach is systemic in nature, and combining them allows us to analyze how the tenets of industrial ecology can be used to design a feasible circular system for companies in textile and clothing industry.

As a means to maximize material and resource efficiency within the textile and clothing industry, we adopt the aspect of industrial ecology that focuses on the interconnection between companies. Thus, our focus is to establish a closed-loop environment where materials and energy waste can be reused and serve as new biological or technical purposes that enables a circular process, where the effluents of one production process can serve as the raw materials for another process.

The transformation of spillage from secondary product and into a primary material or source of energy helps the textile and clothing industry remedy the degradation of the global ecosystem. This secondary upside of industrial ecology proves its ability to design a systemic manufacturing process that falls into step with the boundaries provided by the local and global ecosystem.

The burden on the environment of design-to-costs business models prevailing in the textile and clothing industry makes it even more necessary to establish a textile ecological network of interconnected companies which, on a continuous basis, trade raw materials and textile fibers and share sources of energy amongst each other. Against this background, allowing for industrial ecology in a circular setup within the textile and clothing industry would ensure a closed-loop network of materials - both biological and technical - that is able to reach a balance between production and decomposition.

During our visit to Kalundborg Symbiosis, Per Møller showed us how companies in the Symbiosis, through a strong ecological emphasis, are able to maximize material and resource efficiency as well as transform spillage into primary materials or sources of energy, achieving the effects that we aim to replicate. For textile and clothing companies, managing materials and resources in such a manner can aid them organize value-adding activities and their overall production so that each process renders possible the four different sources of circular value creation. The different companies that comprise a circular and ecological system are more able to facilitate and ease the reverse loops of reuse, repair, remanufacture and recycle, thereby making raw materials and fibers as well as resources restorative. In combining the two ideas, a textile and

clothing industrial system can give companies the means to reduce the environmental footprint, while at the same time increasing their own materials and resource efficiency.

9.2 Changing Relationship Dynamics

The advantages of creating a industrial network are numerous. As our findings showed, the global textile and clothing industry impedes transition to circular business for SMEs. A great deal of the obstacles companies come across are caused by existing deficiencies in the different stages of the global textile and clothing value chain. As mentioned already, the textile and clothing industry organizes its array of value-adding activities within buyer-driven chains. Within these chains, large retailers and strong brand names shape the organization of value-adding activities as well as profits.

Specific to the textile and clothing industry, the majority of activities that make up the stages of processing and manufacturing are performed by first and second tier suppliers located in Eastern Europe in Turkey for example and Asia Pacific (Bangladesh, China & India), (our survey, 2018). Most of the relationships in this buyer-driven chain affected by power asymmetries between global buyers and large fashion brands and the suppliers (Gereffi & Memedovic, 2003).

Previously, we utilized the theory of global value chain governance to interpret the dynamics shaping the global textile and clothing value chain. For SMEs located in Denmark and the Nordic countries, governance within their textile and clothing value chain is often characterized by captive and modular relationships. In captive relationships, small suppliers are highly dependent on the buyers who practice heavy power over them and often decide the business conditions to act under as they deem appropriate. Meanwhile, modular relationships account for the configurations where exchanges and transactions happen naturally, and suppliers use generic machinery to spread investments across a wide customer base with the intend to maintain switching costs low and limit transaction-specific investments. Both of these relationships are evident in the design-to-cost and low-cost-based practices that textile and clothing companies deem imperative to stay competitive.

In the event of a scalable and systemic circular approach to textile manufacturing, a closed-loop network is to rely on linkages based on relational governance. The design and production of circular garments can be defined as somewhat troublesome. For example, producing garments that are made of 100% natural fibers is not straightforward. The design of organic garments and the choice between organic or synthetic fibers might be the least complicated value-adding activities to perform, as was also indicated in our findings - smaller companies do not have any greater difficulties implementing a cradle-to-cradle approach than large

conglomerates do. However, once we reach the stages of processing the fibers and manufacturing the garments, the value-adding activities become more difficult to modify if relationships between textile and clothing retailers and first and second tier supplier remain modular and captive. By the time processing and manufacturing activities have been conducted, these value-adding activities have already reduced the possible circular value that can be achieved in the later stages of transportation, retail, consumer use and end-use.

Therefore, changing the governing relationship between the buyer and supplier is a must. Allowing for wastewater treatment in dyeing, cleansing and rinsing of fibers and achieving higher levels of energy efficiency through the use of renewable sources of energy are just some of the steps that are to be made to ensure sustainable production in a circular model. In order to create circular solutions built on sustainable practices there is a necessity for buyers and suppliers to keep a continuous dialogue. Innovative solutions such as improvements in rethreading technology is dependent on the exchange of complex information that needs to be transmitted more frequently in order to be understood and realized. Therefore, the textile and clothing industry requires relational links to be the norm rather than the exception nowadays as the design and production of apparel requires a high degree of commitment and innovative collaboration between the different companies pertaining to the textile and clothing value chain - which is also in keeping with Gereffi's typology.

9.3 Cost Minimization

The division of labor and the great geographical spread over wide areas of value-adding activities is often sought to organize production processes with the ultimate goal to gain and or withhold competitive advantage by specialization.

The analysis of our findings showed that the obstacles against circularity faced in the textile and clothing industry are mostly encountered by SMEs. By applying global value chain governance theory, we see that the buyer-driven nature of the textile and clothing industry causes the large conglomerates to effectively avoid these same obstacles when dictating rules of the game.

Strategic decisions on whether to produce a garment in-house or outsource the activity to another company can be explained by transaction cost theory (Williamson,1981). Given the search and information, bargaining and enforcement costs in any given exchange, we observe that the level of fragmentation of the value-adding activities a company opts for is a trade-off between production and transaction costs. Similar to the GVC governance framework, where three variables mark the distribution of value-adding activities -

information complexity, easiness to codify and the capabilities of suppliers to meet suppliers' requirements - a resembling typology is utilized in transaction cost theory; asset specificity, frequency and uncertainty/complexity (Williamson, 1981). As the argument follows, if the market for exchanges in the global and textile and clothing industry were perfect, transaction costs would be zero. Yet, with the textile and clothing industry being imperfect, behavioral assumptions - bounded rationality and opportunism - and environmental factors - small number exchange and uncertainty/complexity - ensure high transaction costs. The lower the transaction costs, the more likely it is that the a given textile and clothing company's transaction will happen through the market, and the higher the transaction costs the more likely it is that said company will choose to economize these costs by internalizing the exchange.

Suppliers in the processing and manufacturing stages are affected by bounded rationality and therefore possesses limited skills and knowledge to act in accordance to the wishes and goals of retailers wishing to produce organic apparel. Moreover, suppliers that are geographically distant from their buyers have the possibility to act on their opportunistic behavior and thereby act on their own interest (Williamson, 1981).

Within the configuration of buyer driven global value chains, smaller companies in the textile and clothing industry often find themselves challenged when trying to set up their operations to reduce transaction costs driven by uncertainty in the market and small numbers exchange.

Producing in developing countries and emerging markets allows for companies in Denmark and the Nordic Countries to design-to-cost and keep competitive in an industry wherein the product cycles get progressively shorter.

As our respondents claim, if the production of circular garments has to be achievable, technological advances within the industry need to occur. The transition towards circular practices would need to be supported by product upgrading, process upgrading as well as functional upgrading and chain upgrading. For technical advantages to be enhanced, exchanges in the market to ensure the first, second and third tier suppliers have the required knowledge and specialized skills would amount to high transaction costs. Firstly, for textile and clothing companies to ensure that the chemicals used in the processing and manufacturing processes are not hazardous and do not worsen the quality of textiles, the companies would have to individually spend countless amounts of time and efforts to keep an eye on and have their suppliers under close attention. Furthermore, the activities aimed at a circular production model focusing in the treatment of natural resources as water would also imply strong levels of both process and product upgrading within the areas of management of natural resources in developing countries. Upgrading the value adding activities performed within these steps through product, process, functional or chain

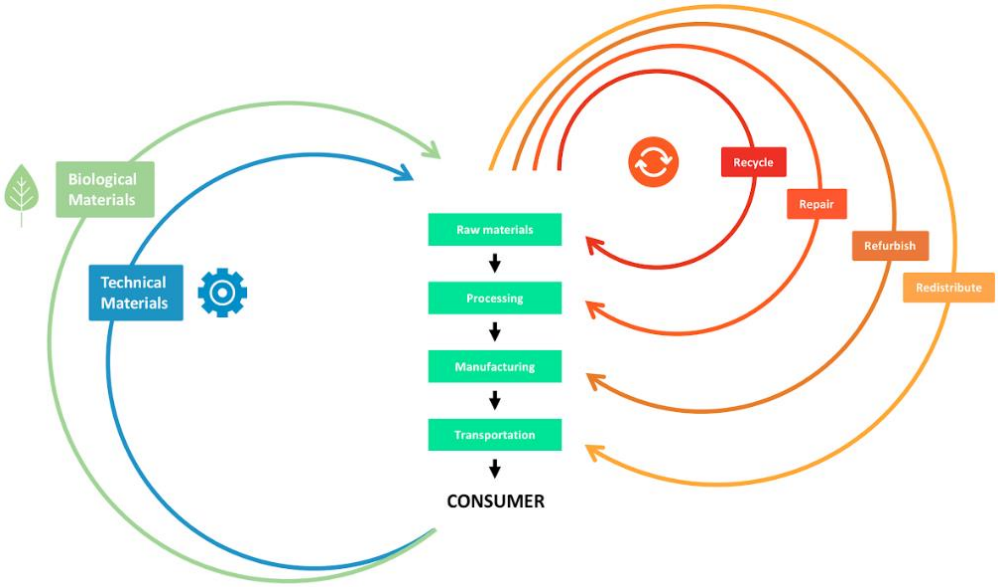
upgrading would improve the environment for small and medium firms to produce sustainable garments. Yet, upgrading equipment for every first and second tier supplier combined with the building of facilities requires a vast amount of capital - a vast amount of capital that in the strong brand names and large retailers in the buyer-driven value chain is not willing to invest.

As seen in our empirical findings, the size of the firm inhibits SMEs wishing to be circular from the full transition to sustainability. This inhibition can be explained by the high information, bargaining and enforcement costs that makes companies unwilling to carry sustainable production of textiles and clothing in developing countries and emerging markets. For smaller firms positioned in buyer-driven value chains, the adoption of a circular business model is a complicated transition and as shown above, the likeliness of smaller firms to be able to do so on their own is neither practical nor feasible.

9.4 Enabling Circular Value

Based on our comparison between circular economy and industrial ecology, we find that industrial symbiosis can be an ideal model to achieve the desired benefits of a circular system. As previously mentioned, the idea of circular management of resources rests on the ideas to design waste out, build resilience through diversity, rely on energy from renewable sources, think in “systems” and the most pivotal one - waste is food.

For textile and clothing companies, the circular management must be supported by recovery activities that close the textile and clothing loop. We have designed the following figure to illustrate a take-back system that enables textile and clothing companies to incorporate the principles of circular economy in their business model.



This systemic approach allows for textiles and clothing to enter four different loops to prolong the life-cycle: i) redistribute; ii) refurbish, iii) repair; and iv) recycle. Once the garments are recollected at their end-of use point and enter the loop again, the quality of the fibers and materials is evaluated before sending the garments to the relevant recovery activity. The model also considers the distinction between biological and technical materials. The separation of the nutrients permits materials and resources to be treated in order to ensure their highest value is kept within the textile circular system at all times. To achieve the effects illustrated in the model, we will in this sub-chapter link what we have analyzed about circular economy vs. industrial ecology, changing relationship dynamics, and cost minimization.

Industrial symbiosis can be used to fit to help the textile and clothing industry design a chain of value adding activities that does not stress the global ecosystem further. The overall goal is to manage materials and resources efficiently and maintain sustainably. Applying industrial symbiosis in this context would entail the design and creation of linkages between several participants in the textile and clothing value chain to engender efficient material and resource flows. During our interview with Lene Dammand Lund, she told us that the construction industry in Denmark has made substantial progress in terms of circularity and that the initiatives have been successfully implemented due to a closer geographic proximity. One of our previously indicated obstacles is the use of chemicals limiting textile recyclability. For SMEs in the industry, hazardous chemicals reduce the value-creation potential related to expanding product life-cycle of the garment.

Another product-related impediment companies encounter is that recollected garments are often too dirty to be treated by washing processes and therefore become unfit for reverse logistics processes. As we can see, the difficulties experienced by companies related to the quality of the garment spring from the decisions made in the designing phase as well as the activities that pertain to the raw materials, processing, and manufacturing stages. However, our respondents also claimed they face barriers to circularity when it comes to the transportation of garments. At this stage, the volume of material back flows are difficult to predict. The large geographical spread between value-adding activities is the root of the problem and inhibits the firms from being able to calculate the quantity and quality of waste streams to use in future reverse logistics processes of reuse, repair, remanufacture and recycle. Therefore, firms attempting to base their product portfolio on circular practices are inhibited by the inability to design circular garments based on anticipated predicted volume and quality of recollected textiles and clothing. Lastly, one of the challenges companies are faced with in the global textile and clothing value chain is the lack of incentive for suppliers to produce sustainable garments. The companies indicate that the industry has changed to accommodate the industrial desire to produce at the lowest cost possible. This structure complicates the sustainable production of textiles as the firms in emerging and developing countries undertaking activities pertaining to the stages of processing and manufacturing are based on practices of low cost and low environmental and social standards.

A method to design the entire continuum of value adding activities so that the system lays out the foundation for circular practices is to allow the concepts of industrial symbiosis and cluster theory to shape the links between the participants of the chain and the activities performed by these.

Within an industrial symbiosis, the whole textile and clothing industry can interact with the global ecosystem and use materials and resources of other industries as inputs into its own processes. The concept of industrial systems allows for a holistic view where industrial activity is viewed as a whole system. Within this closed-loop system engages *"separated industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and/or by-products"* (Chertow, 2000) Furthermore, Jacobsen argues *"Within this framework of inter-firm relationships, IS can be categorized as a concept of collective resource optimization based on by-product exchanges and utility sharing among different co-located facilities"*. By enabling symbiotic relationships between textile and clothing companies, they can now design garments that are processed and manufactured with a lower amount of hazardous chemicals and thereby become more easily recyclable. When located within the same network, companies are able to wash received garments while simultaneously caring for and treating the water. Moreover, the collective arrangement of companies can help them achieve higher rates of collected garments. Not only does the allocation of companies pertaining to the textile and clothing industry within the same network provide results within a short period of time. On the long-run, the incentives for the industry to change their business model become stronger.

Our interview with Per Møller at Kalundborg Symbiose Center showed how it is easy to create the links between the participants of the symbiosis. Nonetheless, the operations of each member of the symbiosis have to be analyzed thoroughly in order to design materials and resources flows that optimizes the capabilities of the symbiosis. The sharing of materials and resources results in lower production costs with fewer purchase and disposal expenses and profits resulting from byproducts. For example, even if water is a central component in the production of garments, the use occurs at many different stages, often accompanied by hazardous chemicals. Outside of a symbiosis, the wastewater is harmful when returned to the ecosystem. However, in a functional symbiosis, the participants can share the water with its varying properties while ensuring its continuous treatment within the symbiosis to sustain other production processes.

An industrial symbiosis can help companies guard themselves against high price volatility in materials and resources and future supply risks. The advantages the symbiosis can create for businesses are manifold and can be classified into following categories:

- Better management and adaptability
- Improvement of the business model
- Increased motivation and market value
- Increased growth and competitiveness

Thus far, we have argued that the business model of an industrial symbiosis can aid SMEs to overcome some of the obstacles encountered within a global value chain configuration. There are still, however, several remaining obstacles, such as the lack of rethreading technology, too high transportation costs as well as the lack of value chain transparency and slow and impractical certification processes. To properly address them, we turn to cluster theory.

One of the turning points in the discourse regarding the concept of industrial symbiosis is whether or not spatial proximity is a requirement for its establishment. As previously indicated by Lene Dammand Lund, the construction industry has been far more successful at implementing circular business models than the textile and clothing industry due to being geographically clustered.

A clustered production can provide the infrastructure needed to support a systematic circular management of resources. It would also remedy some of the negatives related to the geographical spread, such as the lack of transparency and the inability to forecast backflow of materials. In many ways, the clustered production would make the value chain more relational in nature, moving away from the deficient captive and modular chain. Spatial proximity enables smaller firms to gain advantages only experienced by larger players in the industry and by doing so they are able to compete with large fashion retailers (Marshall, 1930).

Lene Dammand Lund's claim about the construction industry is theoretically supported by Marshall. The establishment of a cluster where textile and clothing firms are in proximity to one another gives each individual firm the possibility to explore the six advantages of the setup (1930);

- Hereditary skill;
- Subsidiary trades;
- Specialized machinery,
- Local market for special skill,
- Industrial leadership and
- Introduction of novelties into the production process

For the design and development phase, best practices would entail a considerably smaller production of samples in order to mitigate the materials' negative environmental footprint. Other circular practices that could help enhance circular performance entail the impact assessment of the materials chosen by the designers. When in close proximity to each other, the research and development hub and designers have the possibility to discuss relevant sustainability issues. Such interactions would eventually result in the design of garments where the materials used have previously been analyzed through LCA results, Higg MSI index and other footprint tools. In close proximity, retailers are able to receive the know-how and recommendations on preferred materials that minimize environmental impact. Furthermore, the link between the R&D hub and retailers can help retailers improve the durability of materials used to manufacture garments. Indeed, this first links between two participants (the research and development hub and retailers) can foster the optimization of design recycling where materials are analyzed in order to optimize future waste reduction.

For the second stage of raw materials a clustered production model ensures supplier transparency and traceability, which is one of the obstacles we have encountered several times. The organization of the steps of design, raw materials, processing, manufacturing, transportation and end-use help create a continuous dialogue between all companies. In terms of raw materials, the close geographical allows small retailers to gain a certified sustainable supplier base and enhances the environmental benefits as the provision of guidelines for sustainable sourcing of main materials, e.g. mandatory certifications, minimum compliance requirements can easily be controlled. Also, extended use of garments becomes straightforward as options

for secondary use of the textiles become real and recycling channels are made available for consumers. Within a cluster, take-back models and material processing.

Our visit to Kalundborg Symbiosis Center gave evidence that the advantages Marshall proposes are still highly relevant. Per Møller showed first showed us that a production hub based within a close geographic proximity can help push the companies towards innovative solutions. Additionally, the establishment of a textile and clothing cluster will cultivate the demand for specialized skill, attracting professionals within relevant fields to the cluster. An additional benefit that Per Møller stated was the enabling a greater supply base within the textile and clothing cluster, where synergetic procurement strategies lead to greater supply reliability in the cluster, making them less dependent on imports. Collaborative partnerships between textile and clothing companies not only serves to gain control of material and resource flow management, but it also has the benefit of intensifying the companies' resilience and lessens their exposure to global resource price instability and price fluctuations in the external market (Per Møller, 2018).

Under the circumstances of close proximity, textile and clothing companies are likely to share knowledge and discuss obstacles as well as areas of improvement - creating an atmosphere that engenders technological advancement. Thus, the strength of the companies to develop and innovate within the cluster is greater than in companies outside the cluster.

One of the major obstacles for reverse logistics to become profitable for SMEs is that the process itself is too costly. Additionally, the value obtained through recycling processes is relatively low due to missing technological capabilities. In this matter, achieving higher levels of recyclability would require for the textile and clothing companies to work closely together with reverse logistics companies such as I:CO and textile laundry companies such as Berendsen. For SMEs acting on their own, such a close cooperation is simply to costly and impractical. But with the frequency of interactions and deep relationships between the members of the cluster, the marginal cost between each transaction can be reduced drastically, making take back system and laundry services much more feasible for each SME.

Finally, for a circular business model to thrive in an industrial symbiosis in the long term, a local innovative environment is of great importance. The GREMI group argues that the local innovative milieu can serves as an incubator of both innovations and the birth of innovative firms within the same geographic space. Besides its ability to enhance innovative practices, the environment is based on the organizational and functionals terms embedded in the participants within the textile and clothing cluster. Furthermore, the organization of participants in a cluster formed by companies, universities, government agencies and or otherwise become elements crucial in laying the foundation for efficiency of the clustered production

system. In order to ensure this innovative power, the participants are to have relative autonomy with respect to strategic decision-making. The advantages proposed by Marshall and Porter, such as specialized skills and related and supporting industries are arguably forces that continuously push textile and clothing companies towards a local innovative milieu such as the one GREMI proposes.

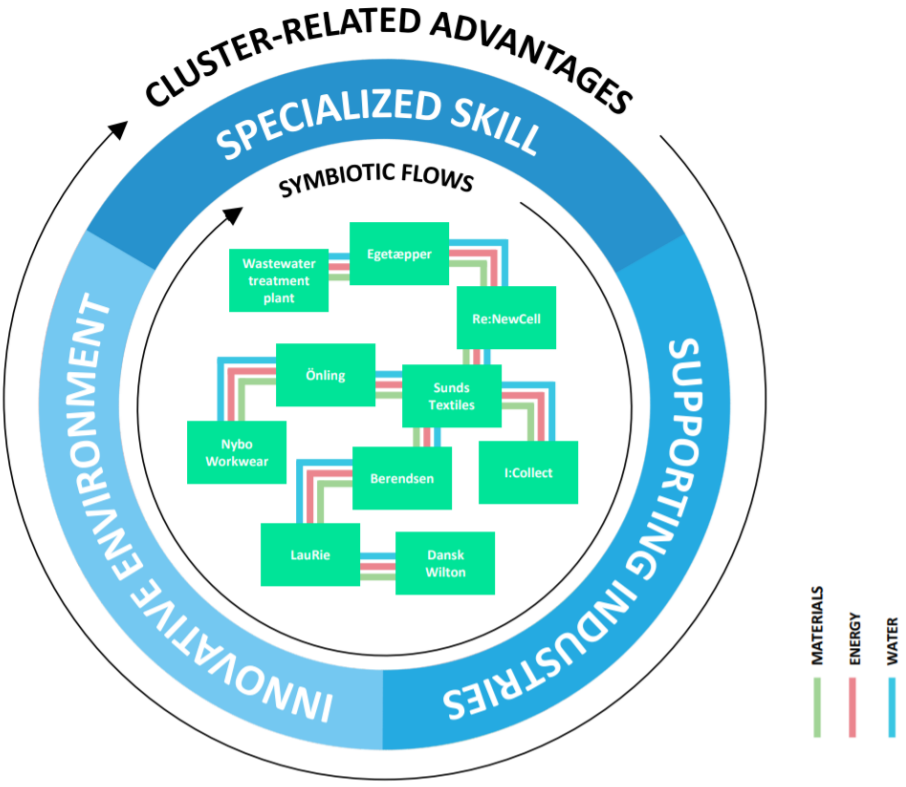
9.5 Summary

The strong degree of fragmentation and the great geographical distance between value-adding activities of the industry's global value chain has allowed companies to stir strategic design-to-cost practices towards developing countries and emerging countries. The theory of global value chain governance has allowed us to demonstrate that the global textile and clothing industry is mostly shaped by buyer-driven chains in which buyers exert a great deal of control and are the main forces deciding how to set up the organization of value-adding activities and the distribution of profits. For our particular study, the different governance types represent the different set up international production and trade systems can take. It is important to understand that governance within a value chain evolves according to the forces that shape industry structures. As our findings have demonstrated, the governance that exists within the textile and clothing value chain inhibits companies from transitioning to circular economy. Modular and captive governance structures reduces the possibility for companies wishing to be circular to achieve greater transparency in the value chain and become more familiar with the practices undertaken in each stage such as the use of chemicals and water usage along the widespread of value-adding activities.

Furthermore, upgrading knowledge and skills of the suppliers and enhancing their capability to become circular would encompass too high levels of information costs, bargaining and enforcement costs. By applying transaction cost economics, our demonstration clarifies the need for textiles and clothing companies to alter their organizational set up if the wish is to minimize production and transaction costs. Organizing value-adding activities within a cluster can allow textile and clothing companies to reduce the transaction costs they incur in a global value chain when attempting to achieve circularity. The appropriate organization of value adding activities of the textile and clothing industry allowing for systemic circular value creation is through an industrial ecological approach which focuses on the establishment of a closed-loop network, i.e. cluster of symbiotic linkages between companies. When engaging in these intertwined linkages, the advantages such as the sharing of material and resource flows and specialized skill, growth of relative and supporting trade as well as the creation of a local innovative milieu permit SMEs to set their own business "conditions".

10. The Symbiotic Cluster

In the previous chapter, we unified the concept of industrial symbiosis and the theory of clusters with our research findings to define the factors that can successfully create circular value in the textile and clothing industry. However, there is still the question of how to put these factors into effect from a practical standpoint. The following chapter will show how we propose to do so. We have designed following model that serves as an illustration of how to unify a cluster with industrial symbiosis. The network is comprised by companies that participated in our questionnaire and which we would deem relevant for the model.



10.1 Cluster-Related Advantages

The outer ring of the model shows the cluster-related advantages identified in the previous chapter. They are an illustration of the compounding feedback of positive effects within the cluster, i.e. benefits that cannot necessarily be measured, but facilitate the symbiosis in one way or another.

10.1.1 Specialized Skill

An important component of the cluster is the enabling of a greater degree of specialization in the circular processes. As established in chapter 8., there are a number of obstacles against circular transition that

relate to a lack of know-how and experience, such as the laborious and unpractical CE certification process or the overt dependence on chemicals. However, as we covered in chapter 9.1, these obstacles can be overcome by way of a cluster's propensity to create synergetic expertise and cultivate specialized skills for the companies within.

The placement of a textile research and design lab, in our illustration represented by KADK, will help the attainment of specialized skills on a continuous basis. Bearing in mind Lene Dammand Lund's sentiment: "knowledge-creation and production should be as closely linked as possible", we imagine a cooperative effort between one or several educational institutes and the companies within the cluster. Lene Dammand Lund herself suggested a dedicated educational hub that would address the necessary qualifications, equipping employees with very relevant and practical expertise to, for example, help optimize the CE certification process and think up new ways to lessen the dependence of chemicals in the textile production process.

10.1.2 Local Innovative Environment

Not unlike the cultivation of specialized skills, the cluster will also increase the level of innovation due to the synergetic effects of the companies' cooperative research and development. This is especially important, since we have established that a lack of the necessary technology poses a serious obstruction to circularity. With Per Møller mentioning that Kalundborg Symbiosis is very far along in the process of developing new technology for chemicals extraction and rethreading, we can surmise that attaining the necessary technology is not only possible within a short while, the process of attaining it is optimized for companies in a cluster with continuous synergetic innovation.
In order to simulate the same innovative advantages that Kalundborg Symbiosis enjoys, The Symbiotic Cluster will be primed for research and development between the companies. Cooperative experimentation can root the technological progress in real production-related issues and will make sure that the improvements are fruitful for the companies of the cluster, in the same way it has been observed in the Kalundborg Symbiosis. The technological research could very well be connected to the textile research and design lab to make sure that educational institutes are involved and gain from it as well.

10.1.3 Supporting Industries

The continuous, compounding positive effects of The Symbiotic Cluster is one of the reasons a cluster is such an effective tool for achieving effects beyond their specific industrial scope. We explored how the textile and clothing industry experienced several problems relating to cooperation with far-away partners,

such as a lack of transparency in the value chain as well as complex and expensive transportation circumstances. In The Symbiotic Cluster, these problems can be eradicated.

With the forming of The Symbiotic Cluster being a predominantly organic process, the idea is that when several textile and clothing companies relocate together in closer proximity, it will naturally attract more companies within the same industry as well as supporting industries to meet additional needs in the cluster - as evidenced by Kalundborg Symbiosis, which has been able to continuously cultivate its positive effects as more and more companies have joined. It is in this case relevant to consider Per Møller's example about an external company joining the Symbiosis to utilize a flow of waste steam and ended up basing their business around that particular flow. Translating this effect to The Symbiotic Cluster, there will be an attraction of companies that see the value in the high demand for certain needs and services in the cluster.

For example, Berendsen would have a steady stream of customers in the Symbiotic Cluster, and in turn the Symbiotic Cluster could provide a cheaper, more optimized way of cleaning end-of-use textiles for companies like Önling, effectively removing another obstacle from the path to circularity. Another case would be suppliers realizing that the Symbiotic Cluster offers a high, steady demand of certain materials that they otherwise do not produce at scale, such as lyocell or modal. Providing an incentive for suppliers to meet the needs for circular production, this attraction of trade and creation of demand will serve to eliminate yet another obstacle and changing the value chains of the companies within the Symbiotic Cluster from captive and modular to be more relational in nature. A company like Önling would suddenly be able to buy said materials without the EU import tariff of 12 %, just as they would be free of the 35-40 % upcharge on their order, since the aggregate demand in the Symbiotic Cluster would raise the volume of lyocell and modal available.

10.2 Symbiotic Flow of Resources

10.2.1 Water

The water recycling in Kalundborg Symbiosis is one of its main advantages, sharing effectively between companies the wastewater that otherwise would have been discarded into the sea. With water being such a supremely important aspect of textile production, the advantages of a similar circular flow of water resources are huge.

The dyeing phase alone is very wasteful in terms of water. Cotton, one of the most popular textile types in the industry, demands upwards of 254 litres of water per kilogram in the finishing processes. If we scale this information to a company that procures textiles at the same volume level as Önling, we can make the following calculation:

Table 3: Cost of water use in cotton-based textile production					
Year	Pieces of clothing	Avr weight / piece, gram	Volume, kg	Water use, liters	Cost of water use, DKK
2016	2.600	375	975	247.504	1.696.378
2017	1.600	375	600	152.310	1.043.925

Assuming the global average for utility water prices, a textile and clothing company with an annual volume of approximately a ton of cotton will indirectly spend 1.7 m DKK on water consumption. While a large portion of that cost lay with the suppliers, this drives up the cost of production services for the textile and clothing company in question. It is of course only a rough estimation, but it still shows the enormous amounts of potential circular value-creation that lies untapped in the value chain for even a small company. With research showing that water can be recycled up to 90 percent of its original output (European Commission, 2016), the potential for bringing down cost of water use is tremendous. Additionally, since recycled water can essentially act as an internal supply of water in The Symbiotic Cluster - as we observed in Kalundborg Symbiosis - companies like Önling are less subject to spiking water prices. For example, in China, where regulatory actions have been increasing the price of water and will continue to do so as the country's water supply gets progressively worse (Lamb, 2016), which would mean that having suppliers based in China is going to get more expensive with time.

10.2.2 Energy

We found no evidence pointing specifically towards any aspect of energy consumption being an obstacle against circularity. That does not mean, however, that there are not inherent substantial energy-related advantages in The Symbiotic Cluster.

While energy is not as large a consumption factor in textile production as water is, there is still potential for companies to optimize energy flows. Especially because there are phases in the processing stage, where textiles are boiled at high heat, and bearing in mind the placement of Berendsen in The Symbiotic Cluster, heat for washing is needed as well. In keeping with how Kalundborg Symbiosis circles energy use, steam used for one part of processing can be used to heat up the water for another process, such as boiling.

Furthermore, wastewater rests around the 30 degrees Celsius instead of room temperature, which is what unused water is at. Instead of disposing of the relatively hotter wastewater, it can be recycled for washing, saving the energy it would take to heat up the water. For a washing service company like Berendsen, this symbiotic flow is a great advantage in and of itself.

10.2.3 Materials

The textile and clothing industry being as materials-focused an industry as it is, the symbiotic flow of materials can almost be seen as the backbone of the reason to enter into The Symbiotic Cluster cooperation. The companies of Kalundborg Symbiosis have at this point already systems in place for exchanging 12 different types of material depending on who needs what. The organic process of the cluster shows in the fact that all of these exchanges come through creative thinking and agreements between the companies with minimal involvement from a moderating third party.
Comparing the above to The Symbiotic Cluster, the process would arguably be even more fluid and easy to execute, since companies pertaining to the Kalundborg Symbiosis are trading very particular materials such as bioethanol, different kinds of acids, biomass, etc., which have to be handled in specific and careful ways, whereas raw materials and fibers being exchanged in this thesis' proposed cluster would arguably be less volatile when transporting them. In addition, Kalundborg being able to share chemicals as successfully as they do points towards the chemicals in textile production being eligible for the symbiotic flow as well.

For a company like Önling, the effects explained above pose huge potential for value-creation, for example enabling them to circumvent the difficulties with forecasting backflow of materials. Should Önling be subject from excess supply after an inaccurate forecast, they are able to sell any surplus off to other companies in the cluster, and conversely, should a excess demand issue arise, Önling is able to buy needed materials to meet the underestimated demand level. In addition to the advantages of such an exchange of materials, the Symbiotic Cluster would also enable Önling and similar companies to track their products throughout their life cycles, facilitating a faster CE certification process as well as engender a high degree of transparency in the value chain.

Looking at recent price developments in the Chinese textile market, relocating to The Symbiotic Cluster to engage in a symbiotic flow of organic fibers seems even more feasible:

Table 4: Development in textile prices, april 2016 - april 2018						
Textile type		apr-16	nov-17	apr-18	apr-16 --> apr-18	price-adjusted
Cotton	Price	7,00	9,11	8,82	-	-
	Growth	-	30,2%	-3,2%	26,0%	20,2%
Viscose	Price	13,8	14,75	14,13	-	-
	Growth	-	6,9%	-4,2%	2,4%	-3,5%

In the table above, the substantial increase of the price on cotton can be observed. Even adjusted for the development of textile prices in general, cotton is getting notably more expensive. Meanwhile, viscose only experienced a small increase in price, and adjusted for the general textile prices, it is actually getting relatively less expensive. This supports the notion that in the near future, organic alternatives to cotton will begin overtaking the markets as the prevalent textile choices.

10.3. Summary

In this chapter we have unified what we previously learned about the textile and clothing industry's obstacles against reaching full circular potential and what changes should be met to overcome these obstacles. By unifying this knowledge and applying more empirical support, we have introduced a business model - The Symbiotic Cluster, that we estimate can enable the changes needed to eliminate the aforementioned obstacles.

We explored how cluster-related advantages like supporting industries, specialized skill and local innovative environment can provide the foundation for a symbiotic network that exchanges materials, water and energy. This model will increase transparency in the value chain, optimize materials and resource efficiency and drive synergetic innovation.

PART V

11. Discussion

Our empirical data in combination with the specified theoretical framework explains how smaller companies in the textile and clothing industry can overcome the obstacles against a circular transition by establishing The Symbiotic Cluster - a business model that simultaneously enjoys geographic and value-creation proximity advantages of a clustered organization in terms of specialization of knowhow, growth of supporting trade and a local innovative environment, among others, and the more measurable benefits of a symbiotic network of materials and resources linkages. However, the recommendation of our business model would be irrelevant to our thesis, if it did not also engender possibilities for circular value realization. We will in this chapter discuss if and how The Symbiotic Cluster will enable companies to draw on the four sources of circular value creation.

11.1 Realizing Circular Value

The large spread of the global textile and value chain, identified in chapter 8.1.2, in its current state is one of the culprits prohibiting the industry from drawing on the power of circling tighter. With such large geographical distances between the links in companies' value chains, it is close to impossible to implement viable systems for recollecting clothes, quickly making them fit for market, and redistributing them. While a company such as Önling receives end-of-use textiles, they would have to ship the garments back to suppliers to have repairs made before having them sent back for redistribution. In The Symbiotic Cluster, the close proximity of suppliers, manufacturers, designers, and the like signifies that most value-adding activities, if not all, of a company's value chain are in close proximity, making the aim of quick-to-market recycled products possible. Imagine again the example with Önling, but instead of having to ship garments across the globe and being subject to different tariffs and charges, Önling simply sends the textiles round the proverbial corner with a truck to a closely located supplier or manufacturer, depending on the state of the textile product. Thus, Önling would actually be able to draw value from a quicker and more efficient recycling of products.

Not only does the global value chain cause these large distances between the links in the value chain that is inhibitive of any circular evolution in the industry. We would also argue that its buyer-driven nature, analyzed in chapter 8.2, is conducive to an overly complex and intransparent network of suppliers, making

it hard for companies to buy durable and organic raw materials in a cost-efficient manner that would give them power of circling longer. With few large textile conglomerates dictating the structure of the textile and clothing industry, smaller companies are forced to have most of their production stages situated not only far away, but also out of their control and supervision. This often limits products to one life cycle or, in the process of trying to make the product fit for longer circling, comparatively more expensive and unfeasible to produce. As we analyzed in chapter 10, the transaction and production cost minimization that comes with a simpler and more transparent network of suppliers in The Symbiotic Cluster will enable textile and clothing companies to both control the production process of the garments as well as drive down the costs of materials such as viscose or modal - materials that would otherwise be more expensive than the dominant materials such as cotton.

Besides the deficiencies related to the geographical spread and the lack of transparency of the global textile and clothing value chain, another central point in our findings was how the level of complexity in the textiles and garments impede the possibilities for circularity. These are all factors that make the power of cascading use next to impossible to draw upon for companies in the industry. While take back systems such as I:Collect are in place to leverage this power, our analysis showed that with the geographical spread of the value chain and the product complexity, it becomes too expensive and impractical for smaller companies to engage in such systems, meaning the global value chain configuration mostly favors the larger conglomerates who operate on a different and higher scale. For a company in The Symbiotic Cluster, we argue on the basis of the points made throughout chapter 9 and 10 that these hindrances would be eliminated. With the closer proximity and attraction of supporting industries, textile and clothing companies would have an easier time of establishing systems for cascading use. Expanding the example made with Önling previously, Önling might not view recollected materials to be of value to them as the textiles received pertain to previous collections, but whereas in a linear business model, the waste of received garments would ultimately be disposed of at a landfill or simply be incinerated, in The Symbiotic Cluster companies would be able to sell recollected materials to interested parties, such as a company like Sunds Textiles that utilizes low-cost textiles for upholstery. The more developed The Symbiotic Cluster becomes, the more different types of cascading use become available to supporting and related companies, further augmented by the increasing level of specialized skill that help optimize textile recycling processes.

Textile and clothing companies rely on chemicals for a multitude of purposes in the production process - most of them being hazardous chemicals that severely limit the recyclability of end-of-use textiles and clothing. The technology for extracting dangerous chemicals and rethreading apparel has up until recently been too rudimentary and underdeveloped for companies to base their business models on circular

principles. This meant that even though the more expensive, organic materials were used, companies were unable to extend products' longevity beyond one life cycle. However, as we point out in chapter 6.1 not only is the industry for rethreading and chemicals extraction burgeoning; the technology is also being developed to a much higher efficiency in Kalundborg Symbiosis, evidenced by Per Møller's sentiments, cf. chapter 7.2.3. Drawing on the power of pure inputs is no longer a distant aspiration but can be achieved with the means currently available. And this is where the symbiotic cluster helps. The effects of a local innovative environment and specialized skill will keep companies in The Symbiotic Cluster at the forefront of the process of utilizing organic materials to their full potential. Using Önling as example once more, instead of remaining in the linear global value chain organization and being subject to the relatively higher prices of pure inputs, as well as lacking the certainty that purchased organic fibers from the intransparent value chain actually are pure, the company could enjoy benefits from economies of scale by purchasing materials with other textile and clothing companies in The Symbiotic Cluster. With the recycling properties of the cluster, the focus on pure inputs would then turn from cost to benefit, due to profits from products in second life cycle that did not cost nearly as much to repair as new products cost to produce.

In general, it can be said about the four sources that they all more or less have compounding effects on each other; the power of pure inputs will enable better cascading use of textiles, and the inner circle leverages cascading use for faster time-to-market channels, to name a few examples. And this is very much the same case with our cluster geographic and value-creation proximity benefits - positive feedback from the symbiotic flows will help engender foster even more specialized skill, etc. Therefore, pinpointing exactly which source of value creation can be attributed to which advantage in the symbiotic cluster can be difficult; in some way or another, all the advantages described throughout chapter 10 contribute to all four sources of circular value creation.

11.2 Opportunities and Threats

Though we have argued that The Symbiotic Cluster activates the full spectrum of circular value creation, this discussion should also include a perspective on short-term versus long-term opportunities and threats for the companies involved. When making a strategic decision of the magnitude that this thesis proposes, any hiccups related to conjoining with other companies into a cluster must be considered: How soon can a textile and clothing company expect to benefit in the short term, and what should they be wary of in the long term?

One of the prevailing advantages to The Symbiotic Cluster strategy presented in this thesis is that it enables incremental implementation. The strategy does not require systemic, regulatory intervention to assemble

all companies in the textile and clothing industry in a specific geographical location, and it also does not demand for all activities of the value chain to be established within the symbiotic cluster at once. The first steps towards a symbiotic cluster can easily be made by small efforts and provide companies with short-term benefits. Preliminary advantages of a symbiotic flow of resources can be achieved just by entering into green partnerships with like-minded companies. Just by sharing procurement and logistics, perks will become available to textile and clothing companies – for example being able to drive up demand of organic fibers and thereby supply of pure materials, which otherwise would be comparatively expensive because of their scarcity; or as another example engaging in synergetic innovation, optimizing certain processes such as CE certification. The benefit of these short-term effects is that the established companies will continuously attract supporting and related trade. Thereby, a textile symbiotic cluster will most likely grow organically as companies deepen their level of synergy in existing partnerships and expand into new avenues of synergy.

However, as important as the incremental quality of the strategy is, it can only support a transition to circularity so far – long-term success is still dependent on a continuous emphasis on expanding collaborative efforts between the members of the cluster. Or, to put it differently: the symbiotic materials and resource flows alone will not help companies gain value from full circularity; proximity-related action has to be taken to reap circular rewards within the symbiotic cluster. Which means that ultimately, textile and clothing companies will have to make certain comprehensive changes to their operations and value chain, namely relocating most of their value adding activities closer together. For example, the aforementioned shared procurement might help with forecasting backflows as well as driving up supply of organic materials, but if the companies are still geographically distanced from each other or from their own value chains, supply and backflow will still be expensive and impractical in the long run, disabling them from achieving higher levels of circularity. The eagerness to collaborate might be present in the short term, but unforeseen factors could change a certain company's outlook, and another company reliant on their presence in the symbiotic flow of resources might suffer for it. Therefore, at least until a symbiotic cluster is realized to the point that most components and services are interchangeable in terms of who performs them, staving off any harmful bounded rationality in the companies is paramount to success.

Another important advantage of our solution is the opportunity it gives the textile and clothing companies to bring down their transaction costs. As explained in chapter 9.3, circularity is deemed unfeasible by SMEs due to not only production costs increasing, but transaction costs as well, since trying to monitor and influence the external links in the value chain is difficult and expensive, and internalizing the links is impossible in the spread-apart global value chain. But in the symbiotic cluster, this internalization is much

more efficient and cost-friendly for companies, enabling them to drive down the transaction costs to accommodate the initial rise in production costs, in effect evening out the overall costs. And since the point was made in chapter 10.2.3 that costs related to buying textiles in the global value chain are expected to increase drastically in the coming years, we argue that production costs in the symbiotic cluster would follow suit in the long term and decrease as well.

Nevertheless, while we contend that the above-mentioned opportunity is systemic in nature and is beneficial to all companies in the symbiotic cluster, we also have to consider the patterns in our findings. For most of the identified obstacles, we found that they were either exclusive to, or at least much more prominent with, SMEs than large conglomerates. From this, one might make that point that large conglomerates stand to gain less from entering into a cluster, since they are already able to be circular on their own, should they wish to. Due to their comparatively higher power over their value chain and economies of scale, large conglomerates could, in effect, set up circular systems without clustering with other companies. Thus, we can surmise that large conglomerates would gain less than SMEs in The Symbiotic Cluster relatively speaking, and that our recommendation might not be fit for the big players in the textile and clothing industry. What is more, since our analysis showed that large conglomerates set the conditions under which smaller companies operate and our quantitative findings indicated that larger retailers do not face the same obstacles as SMEs we argue that it might not be in the business interest of big players within the textile and clothing industry to participate in a symbiotic cluster since their competitive advantages are mostly achieved by conducting design-to-cost practices. This is somewhat in contrast to what Per Møller said about companies of all sizes fitting into Kalundborg Symbiosis and benefitting from the same effects. However, we assert that this is a situation where the Symbiosis differs from our proposed model. It might do so for several reasons, but the obvious suggestion would be that while Kalundborg Symbiosis is not industry-specific, and the large companies of the system are are not in direct competition with each other, while in the industry-specific Symbiotic Cluster, e.g. H&M and Bestseller might not be interested in intertwining much of their respective value chains when they could simply transition to a circular business model on their own - without any of the SME-oriented obstacles.

11.3. Summary

In this chapter, we took our proposed business model, The Symbiotic Cluster, and held it up against the Ellen MacArthur's four sources of circular value creation - power of circling longer, power of the inner circle, power of cascading use, and power of pure, non-toxic materials - and discussed how and if our model and the benefits it enables can help activate each of the four sources. This was a way for us to

ensure that The Symbiotic Cluster not only brought with it the advantages we analyzed in chapter 10, but that it actually did provide a way for textile and clothing companies to become circular - which ultimately is the main objective of the model. Through our discussion, we established that The Symbiotic Cluster can arguably draw on all four sources through the compounding positive feedback from the cluster- and symbiosis-related advantages.

We also discussed the short and long-term opportunities and threats of textile and clothing companies adopting the model. One point was made about the possibility for textile and clothing companies to reap the circular benefits incrementally instead of having to make a full implementation into a cluster in one fell swoop without seeing initial results. This point was countered with the threat that if companies remained at superficial stages of synergy without moving closer together as time went on and expanding their level of collaboration, the incremental benefits would stagnate to the point where disruptive factors such as bounded rationality might set in. We made another argument that textile and clothing companies entering into The Symbiotic Cluster have the opportunity to lower their transaction costs to counteract the initial increase in production costs that comes with a circular transition, and in time, even production costs will be lowered. But with this came the consideration that our findings showed that large conglomerates are not subject to the same obstacles against circularity that SMEs suffer from, wherefore the value proposition of our model is arguably more relevant to SMEs than it is to large conglomerates.

12. Conclusion

12.1 Summary of Findings

To be able to answer the research question of this thesis, we have sought to answer four sub-questions. All four will now be addressed, before we move on to answer the research question.

1. *Which obstacles within the global textile and clothing value chain hinder circular value realization?*

Understanding how value could be created through circularity in the textile and clothing industry, we first needed to identify what factors played into the industry not being circularized. Early in the process, we attended a conference about circular economy in the textile and clothing industry to gain a preliminary understanding of the industry and its challenges to transition to circularity. Afterwards, we conducted a questionnaire among companies of the industry as well as interviews with Lene Dammand Lund, head of KADK, and Lotte Ronan, owner of the micro-sized textile company Önling. With quantitative data from the questionnaire and qualitative data from the interview with an expert in the educational and scientific aspect of textile design, as well as firsthand experience from a company owner in the industry, we were able to identify certain obstructive patterns in the way the industry was composed. We isolated these patterns in eight so-called obstacles in the industry that need to be overcome to make a transition to circular economy viable. The obstacles revolved around issues with geographical distance as well as a lack of transparency between the links in companies' value chains, as well as a high level of complexity in textile products and a reliance on chemicals and processes that limit the products to a single life-cycle.

To ensure that the obstacles were correctly identified, we also wanted to subject them to theoretical scrutiny. For this, we applied the theory of global value chain governance to explain how the current distribution and nature of the textile and clothing industry either caused or reinforced the identified obstacles. We found that the industry's buyer-driven nature favors the large conglomerates disproportionately and causes the SMEs to suffer from captive and modular supply relationships with a large spread between activities, rendering their value chains non-transparent and driving up supply costs.

2. *What are the systemic changes required to eradicate the obstacles, and how can these changes be implemented?*

Next, we had to find a way to identify to eradicate the obstacles. We established that circular economy was in its core idea similar to the concept of industrial ecology as a prelude to explain which relevant advantages can be gained from industrial ecology that can counteract the obstacles, advantages coined

under the sub-concept industrial symbiosis. To not rely solely on semantic concepts, we rooted the analysis in transaction cost theory. We found that the root of the obstacles comes from the fact that SME cannot control the activities in their value chain sufficiently to a point where circularity was possible. Therefore, the industry dynamics need to be changed from captive and modular to relational, and the transaction costs that SMEs incur by internalizing their operations need to be reduced substantially.

We conducted a field trip to Kalundborg Symbiosis as way to help us establish whether a systemic solution for circular value creation could feasibly work in a real-life environment. Data from the Symbiosis coupled with theoretical frameworks from Marshall, Porter and the GREMI helped us determine that textile and clothing companies could create the right atmosphere if they move in closer proximity to one another and create the right atmosphere for circularity to thrive. We determined that the the positive effects of the industrial ecology could be realized through the benefits of hereditary skills, growth of subsidiary trades, use of highly specialized skill, local market for special skills, industrial leadership and introduction of novelties in the production process. We finished off the analysis by proposing a business model that we find can incorporate the cluster-related advantages and support an industrial symbiosis, a combination that will effectively lower transaction costs and change industry dynamics to relational, removing the identified obstacles against circular business models. We named our business model The Symbiotic Cluster.

3. *How can the changes help attain the four sources of circular value creation and what are the opportunities and threats involved?*

For The Symbiotic Cluster to achieve its fundamental object, we had to make sure that the changes the Cluster generates according to our analysis really did enable for textile and clothing companies to feasibly transition to circular business models. To do so, we applied the four sources of circular value-creation - a framework developed by Ellen MacArthur Foundation - to The Symbiotic Cluster and discussed whether our proposed model activated one or more of the four sources, and if so, how. At the same time, we discussed the opportunities and threats that textile and clothing companies might encounter when adopting our model.

In our discussion, we found that all companies will be able to draw from four value-creating sources in one way or another due to both the materials- and resource-related symbiotic effects as well as the innovation-, skills- and cooperation-related cluster effects. We also found that the model gives textile and clothing companies the opportunity to reap gradual benefits as the clustering continuously intensifies, which means they will not have to wait for an expensive and arduous implementation period to be over before they start to see results - but that these gradual benefits will only carry the companies thus far, and the full value of

the model cannot be realized unless the companies also dedicate themselves in the long term to relocate closer to their partners and engender the desired cluster effects.

Furthermore, we discussed how companies in the Cluster will be able to reduce their transaction costs in the short term to alleviate higher production costs, before lower production costs in the long term, ultimately lowering total costs. We discussed how this point should be cautioned with the fact that large conglomerates do not suffer the same obstacles against circularity as SMEs do, and The Symbiotic Cluster might not be as rewarding a business model for the big players in the textile and clothing industry as the small ones.

12.2 Answering the Research Question

The overall purpose of this thesis has been to try and solve the following research question:

- *How can companies within the textile and clothing industry organize themselves in order to realize the proposed value of circular business models?*

Our study proposes a model - The Symbiotic Cluster. At heart, the model demonstrates that textile and clothing companies can organize themselves and their value-adding activities by means of a symbiotic cluster to accommodate a circular business model. By locating themselves in close proximity to each other, textile and clothing companies can enjoy geographic and value creation advantages. Companies are able to discover new sources of competitive advantage as the proximity allows them to affect each other's value-adding activities. In fact, this effect of having an impact on each other's value-adding activities keeps adding to the benefits, such as the attraction of specialized skill, the enhancement of innovative solutions as well as the accomplishment of new technological advances. Moreover, the geographic closeness allows for companies to enjoy other benefits such as the supporting industries and a local innovative environment given the atmosphere of the cluster. Additionally, the second dimension of value creation in our model concentrates on the symbiotic exchanges of materials and resources between the companies where they are able to trade materials and resources, optimizing these flows to fit the purposes of industrial ecology and the circular economy. The continuity of interaction between textile and clothing companies permits for the reduction in information, bargaining and enforcement costs when inside the cluster compared to if the companies outsource value-adding activities elsewhere. Within The Symbiotic Cluster, vertical and horizontal linkages allow textile and clothing SMEs to mitigate human and environmental factors such as opportunism and uncertainty/complexity and to minimize transaction costs when achieving circularity. But in the long run, this decline can also be seen in production costs as the symbiotic links enable companies to

use renewable sources of energy and share material flows within the cluster. The sustainable flows of energy and materials and the geographic placement of the activities to be performed within our proposed value chain can only become real if they are supported by relational linkages where textile and clothing companies provide the most adequate governance of information complexity and codification as well as supplier capability to realize sustainable apparel manufacturing in a circular economy. Lastly, our closed-loop network enhances the possibility for garments to circulate closer to market, longer in terms of life-cycle, become materials to be used in other manufacturing processes in supporting and related industries while also promotes the creation of pure and non-toxic materials which can continuously circulate within the cluster. What is more, our model represents a solution to how the textile and clothing industry can systematically change its environmentally damaging practices and allow for sustainable production that fits within the boundaries of the global ecosystem.

With our geographic cluster of symbiotic exchanges, companies in the textile and clothing industry would move away from environmentally damaging practices that put natural resources such as water under severe stress. Instead, the companies would engage in sustainable production through value-adding activities that focus not only on promoting the use of renewable sources of energy and organic materials, but also on retaining the maximal value of biological and technical materials within the closed-loop network. At the foundation of this solution lie also the geographic and value proximity advantages, such as supporting industries, specialized skills and local innovative environment, that will ensure continuous value creation for the companies in the cluster, rooted in purely circular and ecological principles.

12.3 Suggestions for Further Research

Our study has demonstrated the feasibility of the reorganization of value-adding activities within a symbiotic cluster to be the adequate for textile and clothing companies to establish a closed-loop network that renders possible circular value creation. At an early stage, we defined the scope of our thesis so as to be able to conduct more focused, in-depth research. Naturally, that leaves open a number of other areas of research that could have been pursued, had we had more time and resources.

One such area that we find to be interesting is the power of sustainable branding. Our thesis looks at the decision to run a circular business model from a purely operational standpoint. It could have been fascinating to study whether circularity can factor into a customer value proposition - how much do consumers *really* care about sales arguments such as circularity and sustainability, compared to other factors such as price and properties. During our participation at the Taking the Pulse of the Fashion Industry in Copenhagen, we saw that sustainable brands often lack the ability to market themselves to attract future

buyers. This contradiction can be seen as the present gap between the stated interest and actual purchasing patterns of future customers. Thus, it becomes imperative for brands to analyze whether sustainability is to be included in marketing efforts as it might not have the ability to push demand, and sustainable brands may be better of using organizational and financial resources in other sources of competitive advantage.

Another way of expanding our research would be to include the influence of competitiveness into the business environment of a symbiotic cluster. Throughout our study we have excluded this factor. However, the competition between textile and clothing companies might be an influencing factor. Have we had more time and resources would have found of particular interest to study further, as well as with the power of sustainability branding efforts.

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14. Appendices

14.1. Appendix 1

Interview: Lene Dammand Lund

14.2. Appendix 2

Interview: Lotte Ronan

14.3. Appendix 3

Below the full set of answers from each open-ended question can be seen. Respondents were guaranteed anonymity, so personally sensitive information such as name, position and company has been removed from the appendix.

Which consumer segment(s) does your company operate in? (e.g. industrial workwear, formal business workwear, sports apparel, etc.) Please list in the text box below:

- hunting wear
- Kids Wear - Apparel for Kids
- accessories
- menswear
- Workwear and uniforms specialized for industrial laundry processes e.g. doctors and nurses uniforms, SOSU assistants in municipalities, chefs & kitchen staff uniforms.
- Industrial filtration
- Furniture textile
- Fast Fashion

- Underwear (mostly organic)
- Fashion segment
- jewellery
- Nonwovens used in production of absorbent hygiene products (diapers etc.)
- ladies Wear and childrens wear
- Womens wear
- sports apparel and kidswear
- womens fashion
- Fashion wear
- Medical Devices
- Shirts and ties
- Belts
- Streetwear & Accessories
- Ladies plussize
- Women lifestyle casual fashion
- Garments and furniture
- Young Fashion
- Ladies fashion, target customer are age 35+
- Woman Fashion Clothing
- Various
- Formal business workwear mainly for the aviation industry

- Womens Fashion
- All of above
- Industrial workwear
- Fashion
- womenswear
- Basics
- Children's wear license to LEGO
- Jersey garments , mainly for Women
- Ladies fashion (Créton)
- r6jsjjr
- Carpet B2B and B2C
- Premium womens
- Womens wear
- B2B, KIDS AND WOMAN, KNITWEAR
- Fashion clothes
- Textiles for design

Furniture, curtins acoustic solutions etc.

- Leather Accessories
- Women fashion
- kids clothing
- childrens clothes

- leisure
- Carpet
- Fashion
- Carpets for the hospitality industry (Hotels, Cruise Ships etc.)
- k
- Living & Fashion
- Furniture

Matresses

Construction

Wipes

Automotive

Please feel free to comment on your answers above, if you think there is anything particular to add about the textile process in your company.

- We produce in Polen and Denmark
- Danish production
- From Indonesia, not China.
- Our product manufacturing is in Turkey, Bulgaria and Portugal. As we are fully Oeko-Tex certified, we know all our production places as well as all suppliers of fabrics and trim, printhouses and laundries. We always ask about origin of cotton, but when we come this deep in our supply chain it´s not possible for us to check if the information is correct -as well as for other raw materials we are not able to follow up and trace the origin. Still we keep asking, as it gives an idea and knowledge about where our product comes from and it makes our suppliers aware of the importance of this issue. It´s our responsibility to ensure our products are made as responsible as possible, and the only way to do this is to know the chain.

- Eastern Europe = including Turkey in my replies.

You need to have a box readign: Far East

- we do not produce fabric

- Design and product development is in Denmark

You answered that you did not believe that the current global value chain creates the best conditions for circular business models in the textile industry. Feel free to elaborate on your answer:

- The challenge for our products is that they become dirty, and therefore difficult to handle after use.

Also the cost to recycle the felt is really high, and difficult in a really price demanded market

- I am absolutely sure that there will be a big change, when these 2 things happen.

1. The companies realise that to protect their own business, they need to reuse and recycle.

2. The consumers realise that the over consumption of the Western World is actually the main problem for the planet. Meaning, if this has to change we has to change

- we need to think more recycle and the logitic needs to be improved , fast electricity rail tracks from east to west .. avoid air freight of the shipments best possible.. (today not enough vessels for seashipment, overload of production which needs to be moved from Asia..)

make the production more tecnical /robots and mowe the production back to Europe/ consumer market for basic production , that will save the transport, save energy , much better for the envoirement..

- We are changing the processes so we save a lot of time.

- lack of transparency

- CSR cost a lot of changies and money and thats why many companies dont work whith this

- Again I am not sure what your terms circular business model means.

- There are very few posssibility for recycling fabric for smaller scale compagnies.

- As the situation is today, I think it´s might more important to look at the brands and the end consumers. Our supply chain does what we (fashion business) have trained them to do; finding the cheapest options for producing huge quantities -without any damands for responsible production. This situation does not create any circular business or awareness. Brands must take their responsibility in their supplychain and consumers must learn that a pair of jeans should not cost 10 eur. Then we as brands can produce the quantities needed, for a price where all parts gain -making a product the customers care for and keep for a longer time, as well as the reuse of the materials or final product can be a integrated in the design process -but this is difficult if all parts in the development process, materials and production should be sheapest possible.
- Only quality issues need to be presented/dokumented. None circular.
- Distances are mostly too far
- The turning point around all business is always money. I see very much interest in circular business models - but as soon as it costs money - most company not so interested anymore.

This is especially true when looking at an international approach.

- It's hard to do when you are a small company.
- The value chain has to collaborate to find solutions for re-cycling or re-use of used carpet.
- I believe in a more tight chain and keeping the product cycle as tight and close to market as possible.
- There is a huge potential for circular economy but right now the current global value chain does not take advantage of all this potential. We are working a lot with cicularity and feel convinved that more companies in the value chain will see the value of working with circularity.

Which adjustments to the global supply chain of the textile industry would you say were the most necessary to improve the conditions for transitioning to circular economy? Feel free to elaborate below:.

- Separating the fibres, so the fibres can be recycled.
- see previos comments
- Better and easyer to get fabric around the World. And better contry cooperations and lower taxes

- more transparency
- Supsidies from government organisations, or neu restriktions
- We need access to raw material that has been circulated. I think fabrics have yet to be developed.
- Infrastructure that can support the consumer in recycling, and suppliers that are willing to work with recycled raw materials.
- Besides my comment to previous question, the development for reuse of fibers still needs to better developed.
- Require circular EN-norms
- Maybe operate more local.
- Money talks! So it should cost more to avoid circular economy.
- More transperency more advanced techniqies to recycle or track the products lifetime.
- The mindset af business strategy should see waste as a resource and integrate it in the circular strategy in the business from product development and into new lifecycles.

Which challenges, if any, has your company experienced when implementing reverse logistics in the company's business model? Feel free to explain below:

- Take back systems of used furniture textiles from users, it is too complex and expensive at the moment
- all to complicated
- Xx
- Actually you cannot recycle as much as expected, as the Chemicals in garments

already used cannot be documented and checm restrictions are tighted every year. Secondly by redying/recycling fabrics you use higher percentage of dyestuff and Water compared to a new production.

- Recycle techninqies

- Logistics and forecast, it can be tough to predict volume and flow of certain qualities of waste streams in order to ensure a proper input and quality.
- Our products are developed with different materials merged (glued together)

Which, if any, obstacles has your company experienced that prevented the company from implementing reverse logistics to a higher degree? Feel free to explain below:

- Again, our product are becomes dirty in use.
- Too many suppliers, too traditional thinking in general in the business.
- Contry Tax
- Medical Devices - not legally possible.
- Dont know what you mean by reverse logistics. Our garments are not returned to us after the consumer is finished using them. But I can see that they are reused through trift shops or personal sales, and our garments do have a long life-span as the quality is good. But how to reuse 100% viscose fabrics?
- Today we only have a plan for our second hand goods; goods that has got back from customers due to flaws or goods we have found 2nd grade in our quality control -these pcs are checked so we can learn by the flaws to avoid making the same again - then these pcs are all sent abroad for charity.

If we receive a production with flaws, were repair is possible, all pcs are sent back to production place or service house for repair of the garment. This as the goods are to valuable to be thrown out, production of new fabric will delay our customer delivery too much -and it learns our producers to be careful in production.

- Too much admin in getting approvals for CE like certificates

We don't go for organic fabrics, we just make a better choice whenever possible, which is most of the time..

We use robust materials to give looooong use time of styles, rather than having a return channel, but we have discussed how to implement a deposit system with our clothes..

- Mindset

To see the real cost (not just in $)

- Lack of experience and resources.

Lack of existing knowledge for this product type in general

The fact that a lot of refurbishments of cruise ships take place at destinations far away from us

Which challenges, if any, has your company experienced when implementing reverse logistics in the company's business model?

- We still Work on it
- Not been there yet
- It's hard to implement reverse logistics when you are a small company.
- There is no converter to go to. We have to do everything our self .

Also transport costs is a problem

Which, if any, obstacles has your company experienced that prevented the company from fully implementing a cradle-to-cradle approach? Feel free to explain below.

- Same as above. Cradle to Cradle is not suitable for fast fashion.
- high minimum in materials that are more sustainable
- We use almost exclusively 100% viscose for our products. We find that we miss a global acknowledgement as to what resources are best for garment use in the sustainable and cradle-tocradle approach. One alwasy hears that organic cotton is good, but in actual fact all cotton production is very tough on the environment. So how does 100% viscose compare to cotton? I cannot find any info on this and it is not in the public awareness. Our garments are long-term garments and have a long life-span... how can we get this concept across to the consumers who are more interested in price?

- Unfortunately we have not really started this process. As we don´t have own shops, it will be difficult to collect and return used garments, and a cradle-to-cradle seems overwhelming when there are so many places in this industry that needs improvement.

What we have done, is focusing on the materials we use in our collections; choosing as sustainable as possible both in the aspect of raw materials and the processes used. Furthermore, we only produce what we need, as we sell first and produce afterwards. Our choice of production countries also comes from our sustainable view; we want short transportation, close contact with our producers -we visit most of them 2-4 times a year. This creates understanding of both parts in the business, and help us have influence on the conditions in our supplychain.

- Once the products are out of our hands, we can't control what the customers do with the products and how they dispose them.

- Collection of the clothes

- Fulfilling customer and licensing requirements in many different areas takes more than full time. Unfortunately, we do not see demands from them for environmental issues at this level.

Feel free to elaborate on your answers in the text box below:

- We recycle +85 % of our waste but our products can not legally be reused or recycled (Medical Devices)

- This is a bad questionare. You assume the the respondent have the same knowledge as you.

- Most of our collection are designed for long lasting, both in design and quality, so in this aspect we have a high focus of our garments "circling longer"

- All suppliers have been visited and inspected on social responsibility on employees and environment...

- Relating to the questions of implementing C2C principles: We are very close to achieving a C2C certification, however, the implementing of changes will happen over time.

- Dear both,

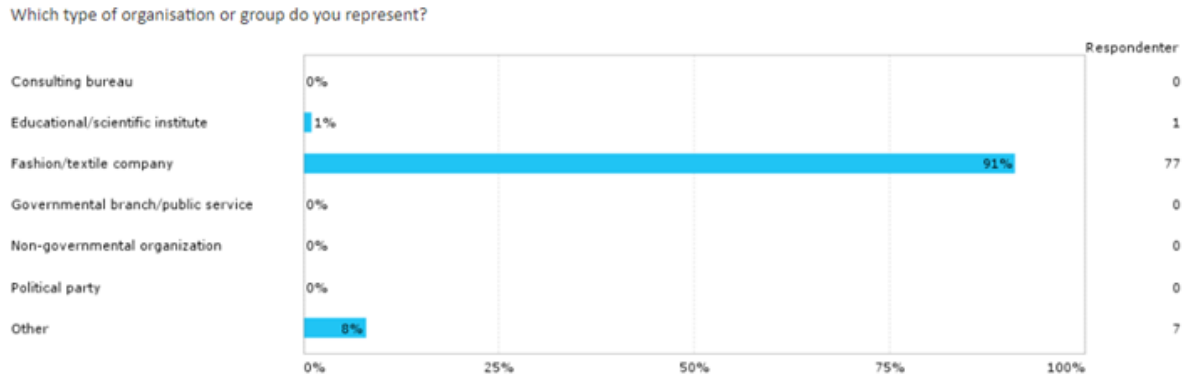
I will be happy to read you Master Thesis, as I´m eager to learn about your conclusion. I hope DM&T will help and send information when it is ready.

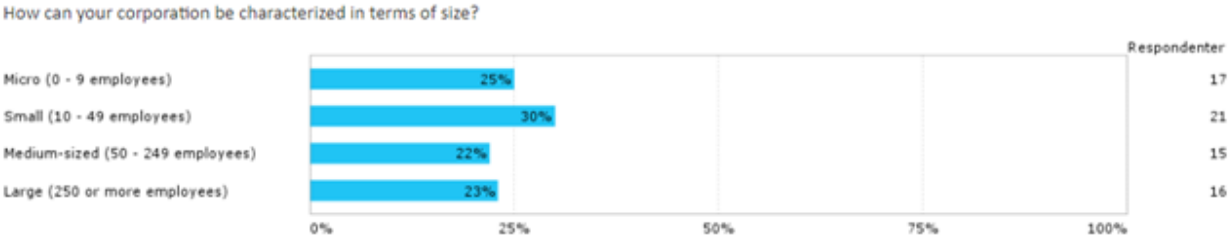
If you have any questions to my replies you are welcome to contact me on [removed]

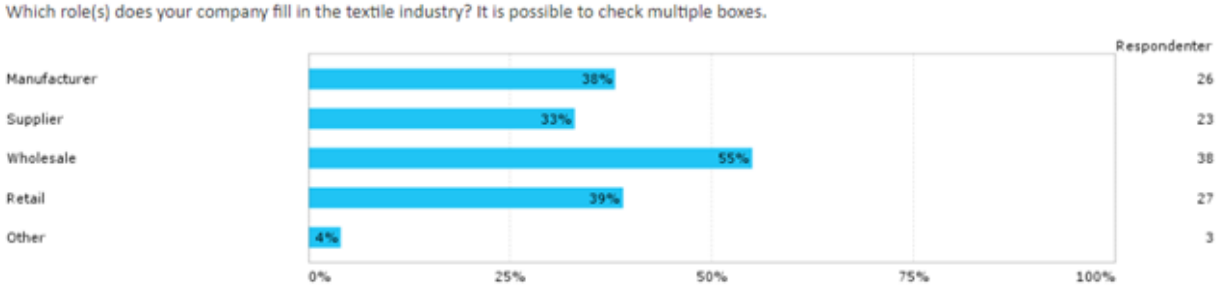
Best regards

[Removed]

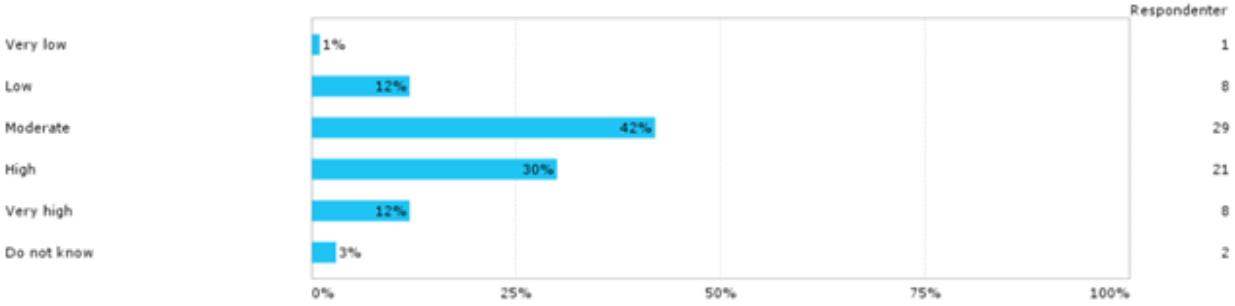
14.4 Appendix 4



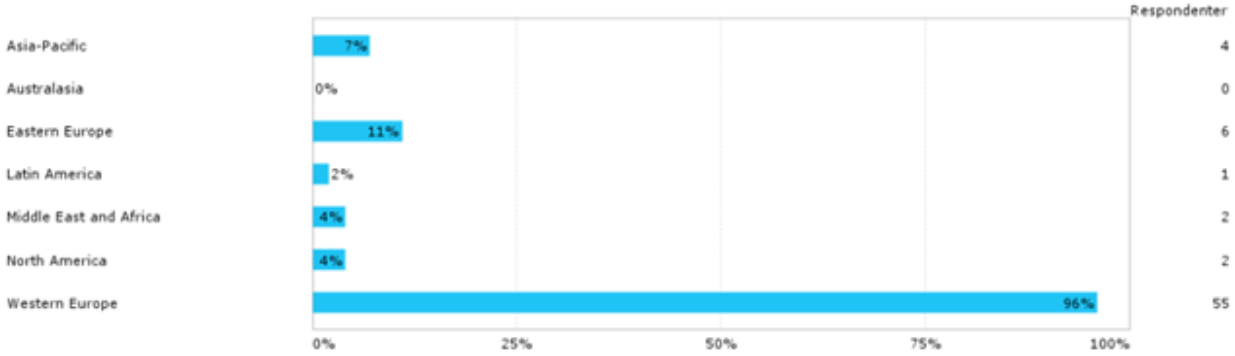




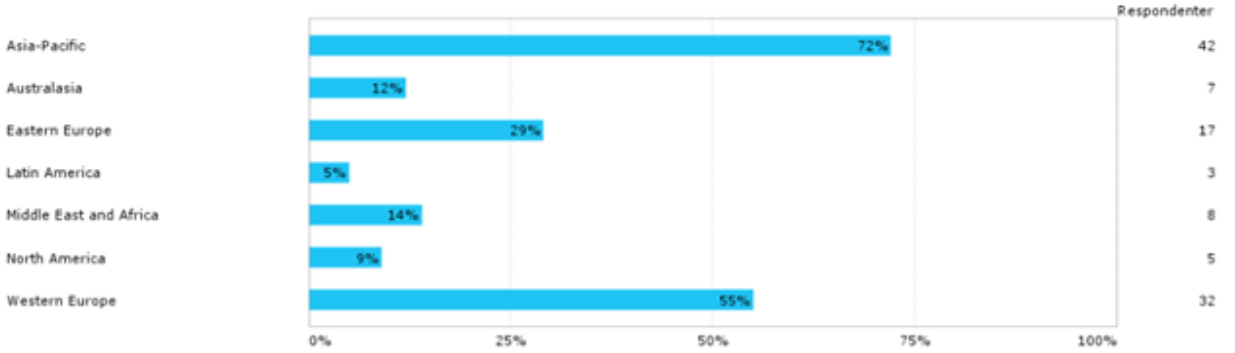
Looking at your company's product portfolio, how high or low would you say the complexity of the products are in terms of raw materials and basic components?



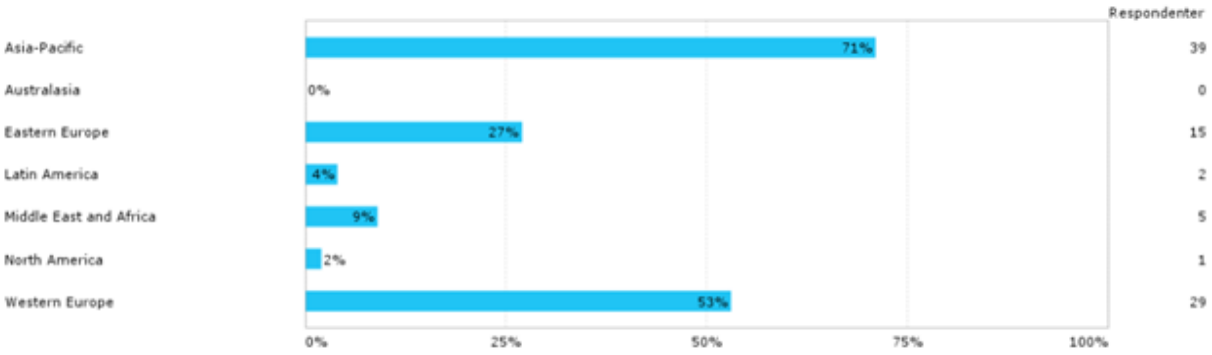
Design and product development - In which region(s) does the activity take place?



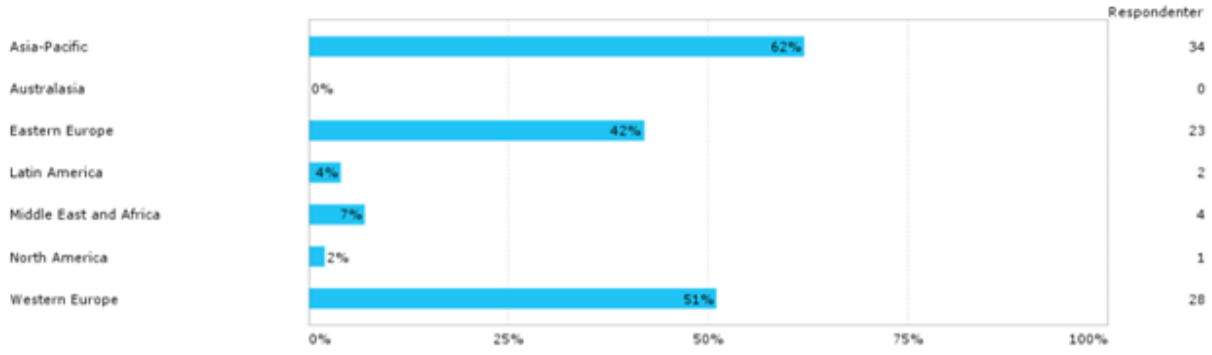
Raw materials - In which region(s) does the activity take place?



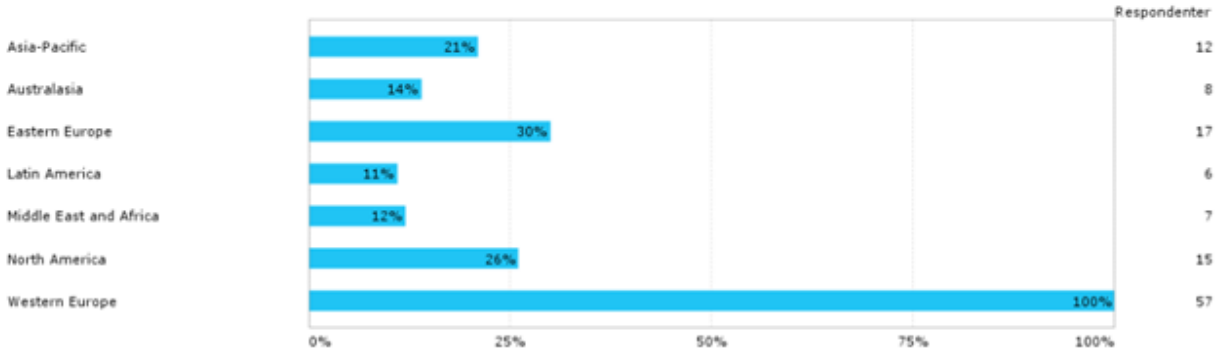
Fabric production - In which region(s) does the activity take place?



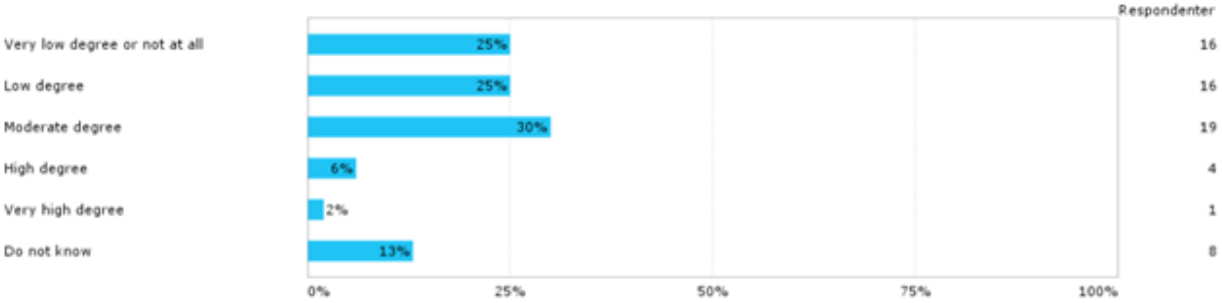
Product manufacturing - In which region(s) does the activity take place?



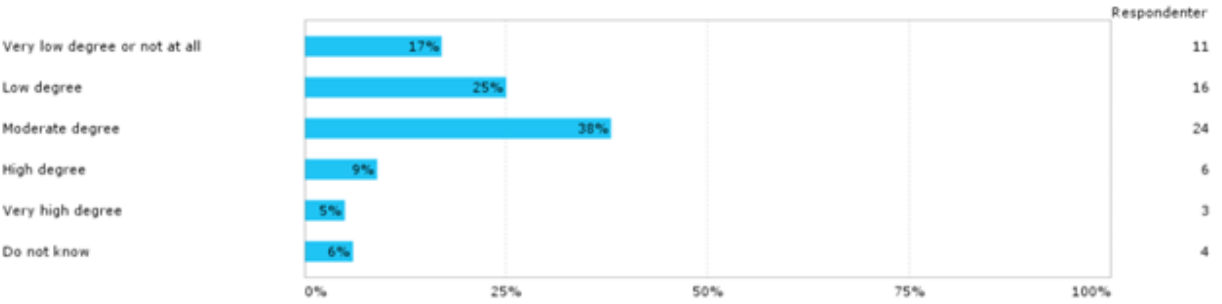
Sales, retail, marketing - In which region(s) does the activity take place?



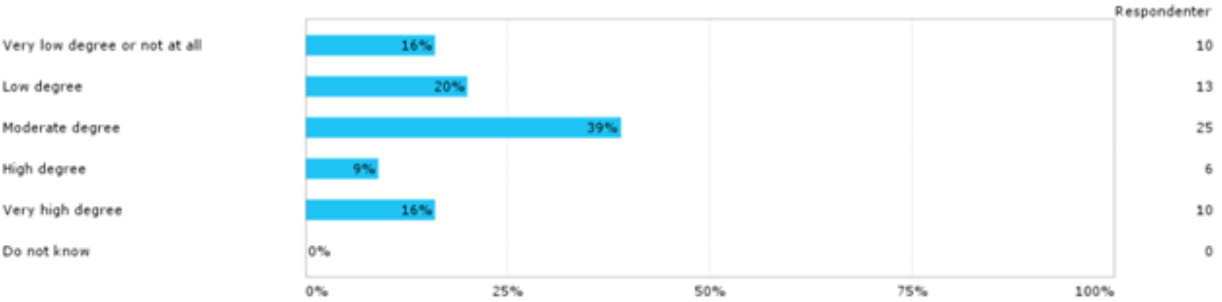
To which degree has your company successfully implemented reverse logistics in its business model?



To which degree has your corporation successfully implemented a cradle-to-cradle approach to its design process?

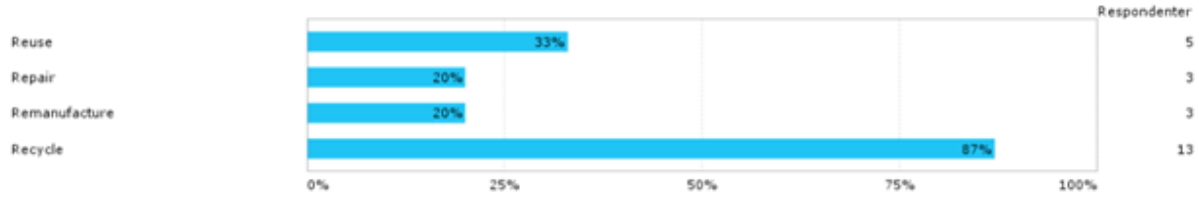


To which degree is your company able to impose circular and/or sustainable practices on the company's suppliers and partners in the textile production process?

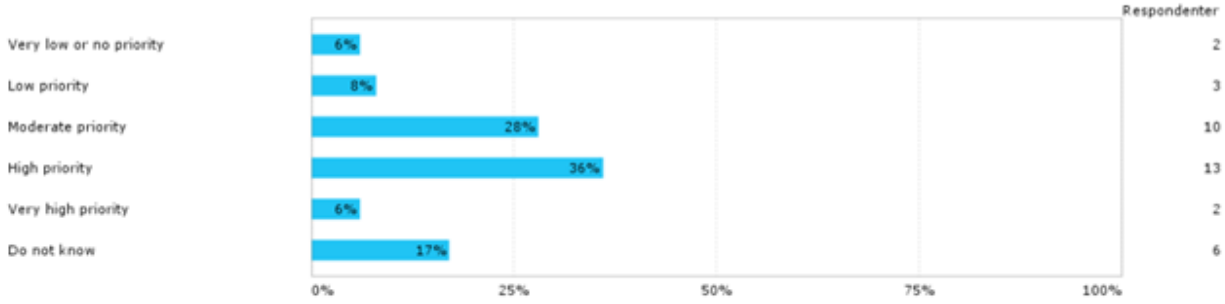


Do you believe that the global value chain as it is now provides the optimal conditions for circular business models?

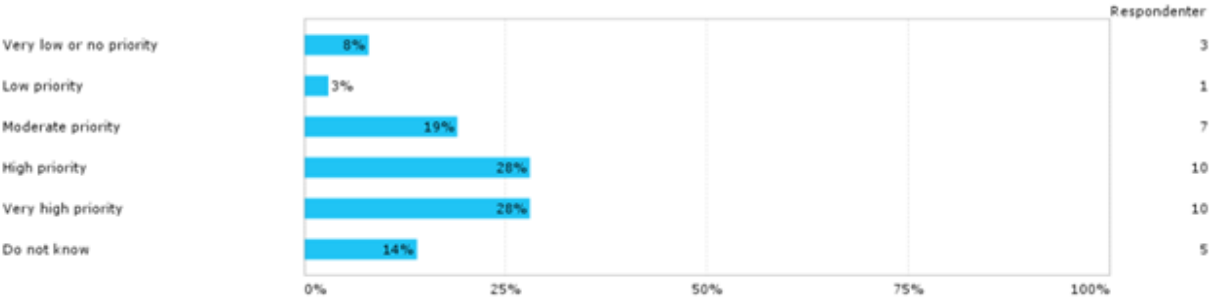
Which part of the process of reverse logistics does your company you focus on? It is possible to check multiple boxes.



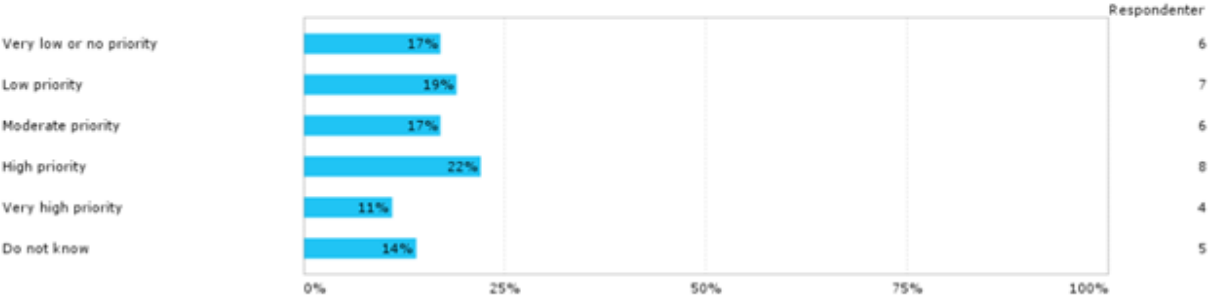
"Power of the inner circle" - keeping the product cycle as tight and close to market as possible



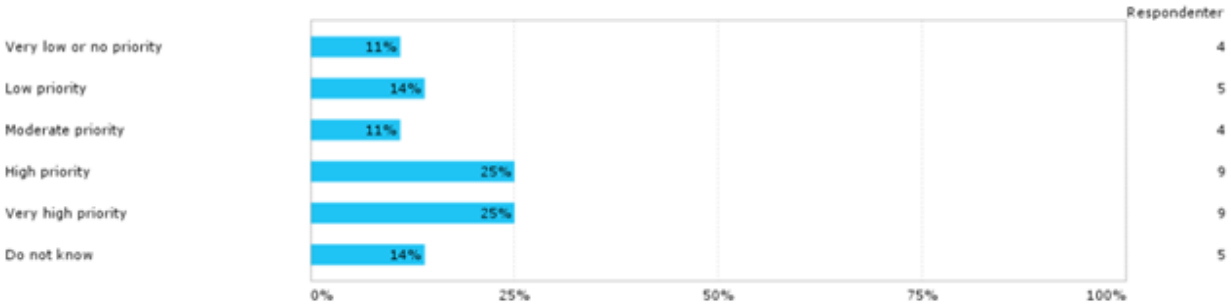
"Power of circling longer" - Prolonging the time of the product cycle / extending the number of cycles the product can maintain



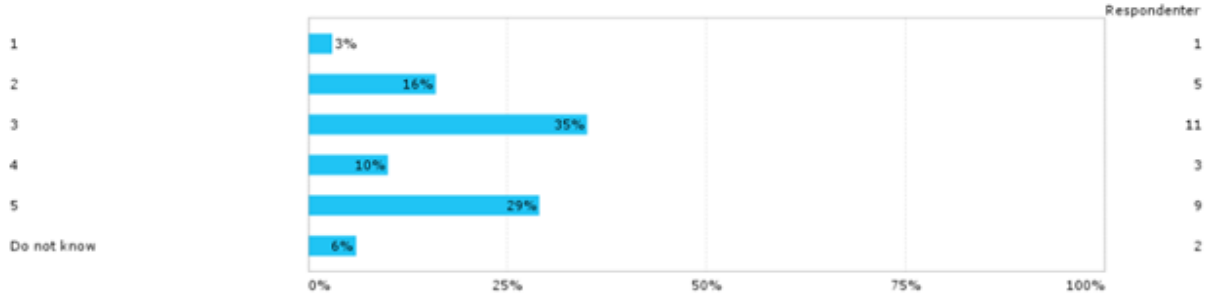
"Power of cascaded use" - using inbound resources from one end-of-life product to create or repair another. (E.g. creating fibrefill for furniture from cotton-based clothing)



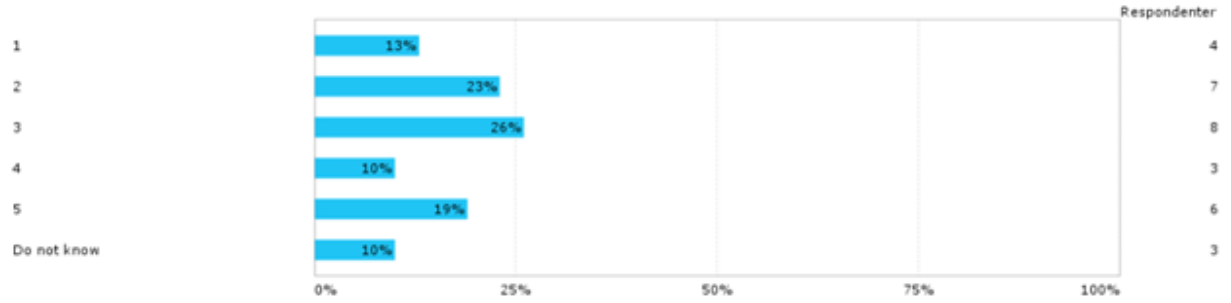
"Power of pure, non-toxic, easier-to-separate inputs and designs" - designing for purity of materials to ensure interchangeability between products



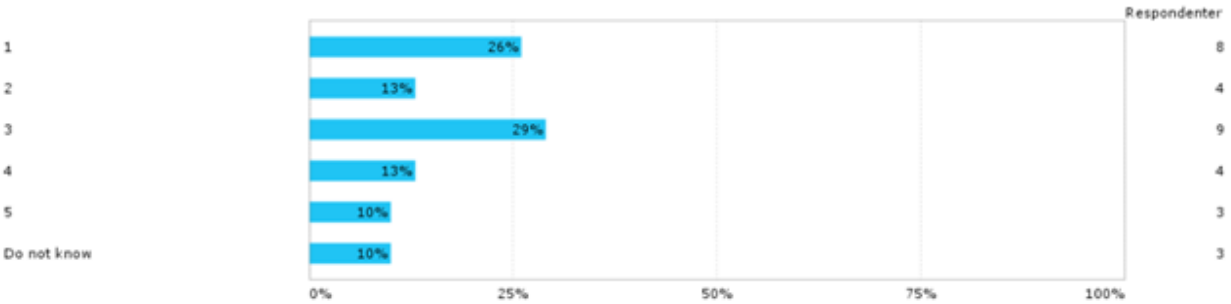
Sustainable fibers - 1 = Not implemented/no plans for implementation 5 = Fully implemented



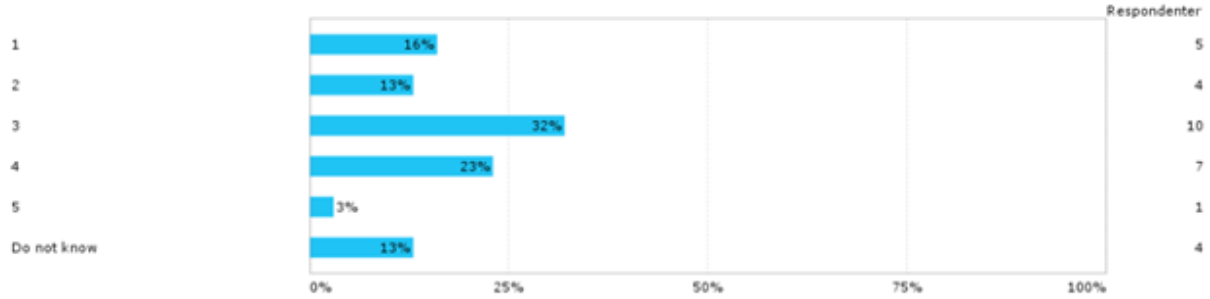
Low-impact materials - 1 = Not implemented/no plans for implementation 5 = Fully implemented



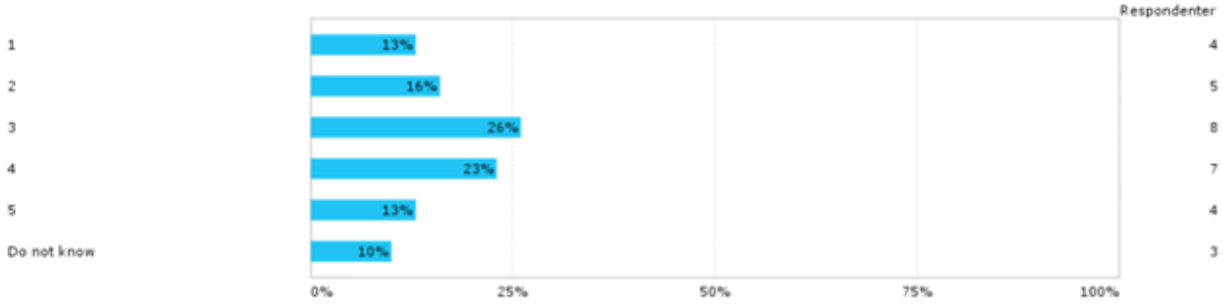
Renewable source of energy - 1 = Not implemented/no plans for implementation 5 = Fully implemented



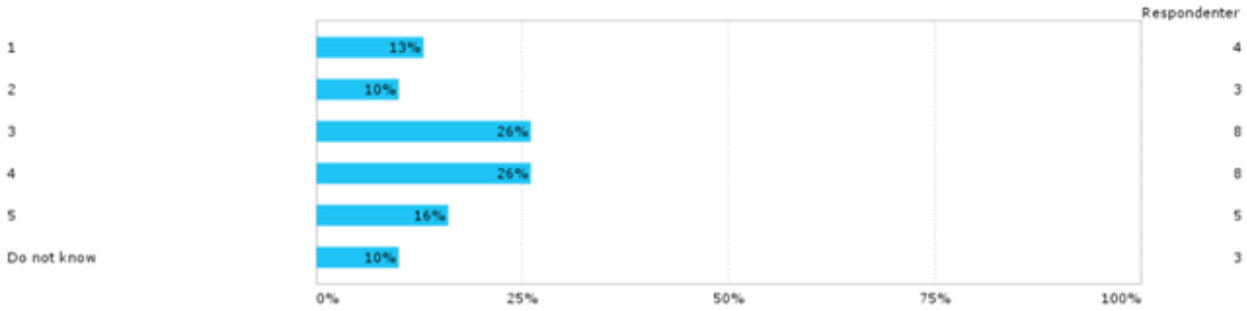
Energy efficiency - 1 = Not implemented/no plans for implementation 5 = Fully implemented



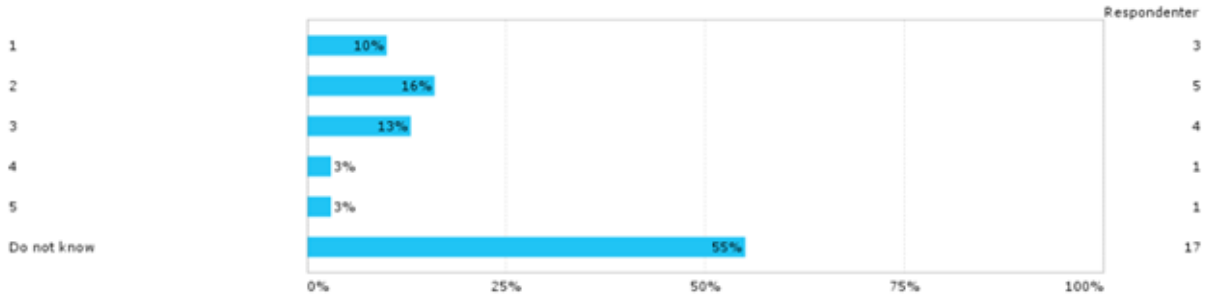
Water efficiency - 1 = Not implemented/no plans for implementation 5 = Fully implemented



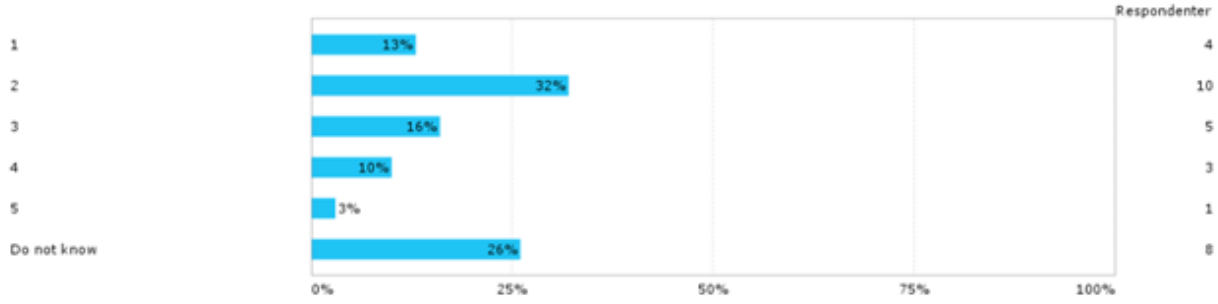
Waste management (recycling and reduction of material) - 1 = Not implemented/no plans for implementation 5 = Fully implemented



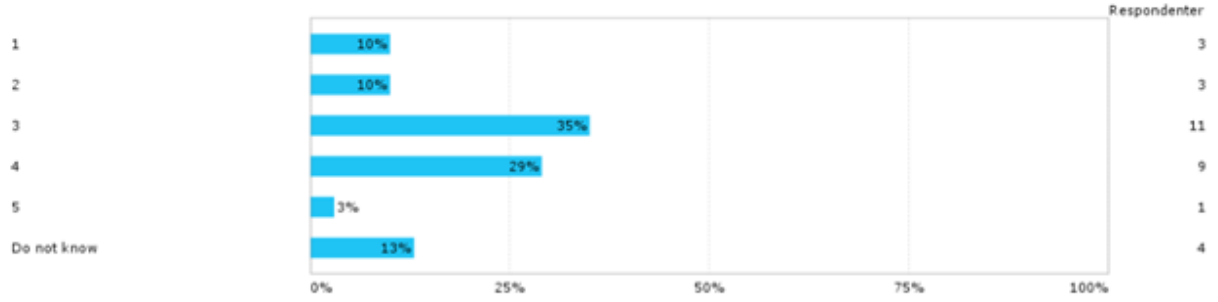
Biomimicry - 1 = Not implemented/no plans for implementation 5 = Fully implemented



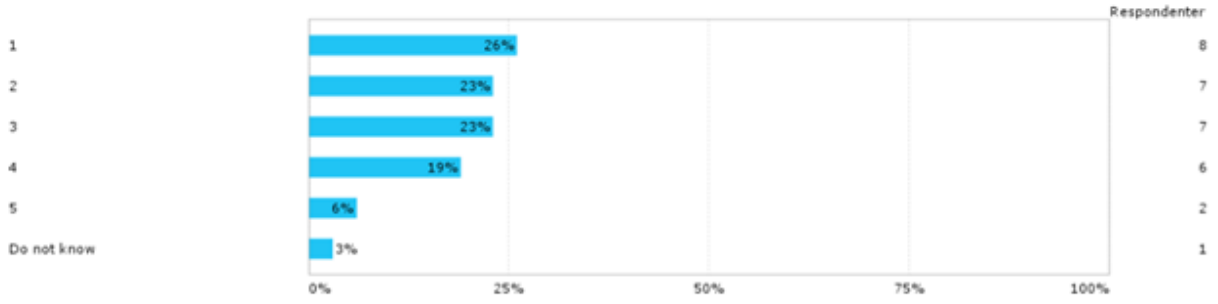
Biodegradable products - 1 = Not implemented/no plans for implementation 5 = Fully implemented



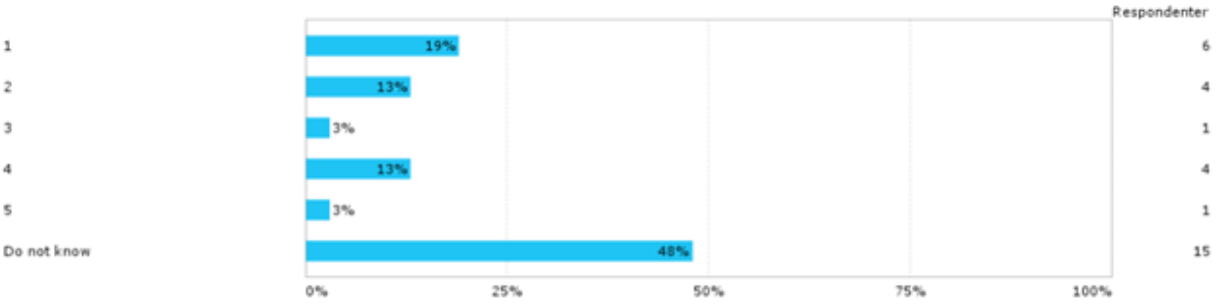
Pollution prevention - 1 = Not implemented/no plans for implementation 5 = Fully implemented



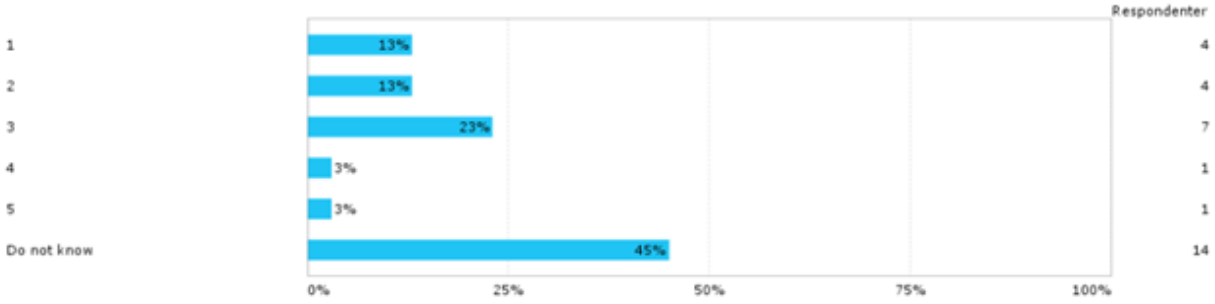
Design to reuse and recycle - 1 = Not implemented/no plans for implementation 5 = Fully implemented



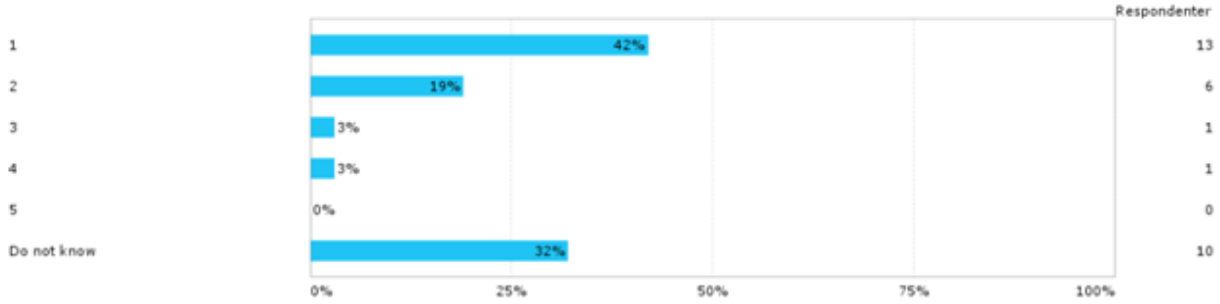
Community couture - 1 = Not implemented/no plans for implementation 5 = Fully implemented



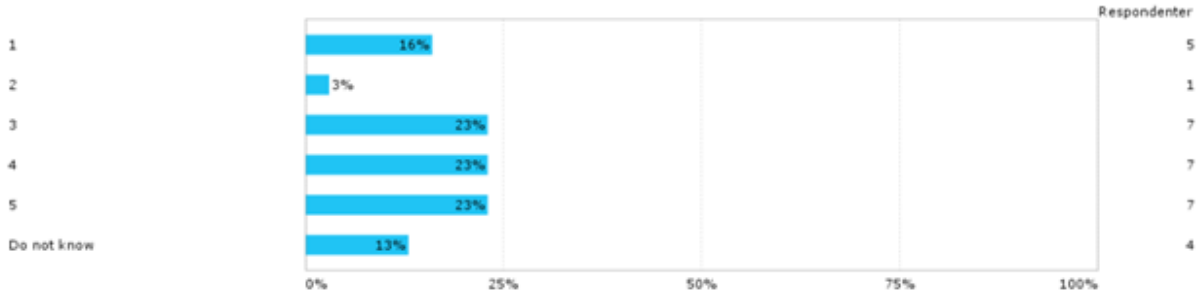
Service substitution - 1 = Not implemented/no plans for implementation 5 = Fully implemented



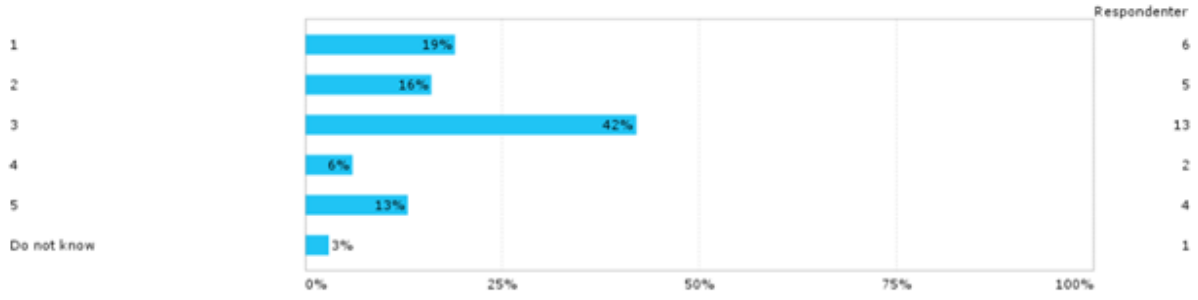
Do-it-yourself and patchwork - 1 = Not implemented/no plans for implementation 5 = Fully implemented



Fair trade/ethical practices - 1 = Not implemented/no plans for implementation 5 = Fully implemented



Near-sourcing - 1 = Not implemented/no plans for implementation 5 = Fully implemented



14.5. Appendix 5