M.Sc. Thesis in Business & Management
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Circularity through Collaboration

A Case Study on Textile Industry

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Abstract

In the last decade, circular economy (CE) has gained widespread attention among scholars, practitioners, and policymakers as a sustainable alternative to the current linear system. This system, which operates under the logic of "take-make-dispose", poses significant threats to our environment due to the exponential growth in natural resource extraction that we have witnessed in the last fifty years. The circular economy concept proposes an economic system that emphasizes the efficient use and reintroduction of resources back into the system instead of disposal in landfills. Despite growing interest, the adoption of circular economy practices remains low. In the existing literature, collaboration has been identified as a significant driver for circular economy adoption, yet it has been studied only recently and sporadically. Furthermore, the existing literature does not explain in detail how collaboration can be used to drive circular economy adoption. Scholars have also noted the limited use of systemic perspectives to study complex phenomena like circular economy. Building upon existing literature and adopting a holistic framework based on Systems theory and System thinking, we conduct a qualitative case study in the textile industry to explore how collaboration can drive the adoption of circular economy. Our findings suggest that various types of collaboration can help overcome barriers to circular economy and drive its adoption. Finally, we introduce the concept of "circular lock-in" to discuss how circular economy strategies and practices can become the norm in an industry or face systemic resistance.

Keywords: Circular economy, collaboration, CE strategies, system perspective, textile industry

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Glossary and Abbreviations

Circular Economy (CE) : A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations.

Linear system: A system where raw materials are transformed into products that consumers use until discarding them as waste out of the economic system.

Waste hierarchy: A conceptual framework designed to guide and rank waste management practices at individual and organizational levels.

Narrowing: Using fewer resources per unit of output.

Slowing: Extending and/or intensifying the use phase of a product to reduce the amount of resources flowing throughout the system.

Closing: Close the resource loop by reintroducing into the system what in a linear economy is considered useless waste and disposed of in landfills.

Holism: Practice wherein parts of a whole are considered to be in intimate interconnection, such that they cannot exist independently of the whole, or cannot be understood without reference to the whole, which is thus regarded as greater than the sum of its parts.

Reductionism: Practice of analyzing and describing a complex phenomenon in terms of its simple or fundamental constituents.

Systems thinking: Way of making sense of the complexity of the world by looking at it in terms of wholes and relationships rather than by splitting it down into its parts**.**

System: A collection of entities and their interrelationships gathered to form a whole greater than the sum of the parts.

Processes Subsystem: Subsystem involves the flow of resources across all the activities.

Actors Subsystem: Subsystem comprising of all the stakeholders involved.

Values Subsystem: Positive and negative impacts in the environmental, economic, social, and technical domains as influenced by the respective processes and stakeholders.

Formal collaboration: Collaboration arrangements based on comprehensive and detailed contracts that rule all aspects of collaboration.

Informal collaboration: Collaboration arrangements based on personal links, common interests, common values or non-written, tacit rules and agreements.

Captive collaboration: Collaboration arrangements where a dominant and more powerful partner defines and closely monitors rules and processes.

Relational collaboration: Collaboration arrangements where partners have similar power and switching costs and define rules jointly through frequent interaction, trust, and shared experience.

Assessment-based collaboration: Sit between relational and captive.

Centralized collaboration: Collaboration arrangements where the interactions are coordinated through a central hub.

Decentralized collaboration: Collaboration arrangements where the interactions are coordinated through ad-hoc arrangements between the parties.

1 Introduction

Global Gross Domestic Product (GDP) has doubled since 1970, fostering substantial progress for humanity and lifting billions of people out of poverty. However, as highlighted by the (UN Global resources outlook, 2019), this growth came at the cost of an exponential increase in natural resource extraction, with a consequent alarming increase in negative externalities related to resource scarcity, climate change, loss of biodiversity and natural capital, land degradation and ocean pollution (Lieder & Rashid, 2016; MacArthur Foundation, 2015). In 2021, humanity consumed resources equal to 1.7 earth, yet only one earth is available (Blum & Wackernagel, 2021); in other words, we demand more than the earth can renew. These trends are likely to exacerbate as the middle class worldwide is expected to more than double in size by 2030 (Ellen MacArthur Foundation, 2015). Working toward efficiency – reducing the resources and fossil energy consumed per unit of economic output – is necessary but insufficient. Numerous researchers, practitioners, and policymakers have called for a paradigm change from a linear to a Circular Economy (CE)(Morone & Yilan, 2020). While the linear logic, also called cradle-to-grave, is based on extracting resources from nature and disposing of them as worthless waste (Dhonde & Patel, 2020; Kirchherr et al., 2017), CE operates under the premise that resources are finite and proposes a rethink and redesign of processes to use resources more efficiently and reintroduce back to the system what in a linear logic is disposed of as worthless waste (Ghisellini et al., 2016; Montag, 2023; Murray et al., 2017).

CE has gained exponential interest from policymakers, practitioners, and academia in the last decade due to its potential for sustainable development (Lüdeke-Freund et al., 2019; Montag, 2023; Ghisellini et al., 2016; Mont et al., 2017). Despite increasing efforts from various societal actors, the level of adoption of circular practices is still low (Kirchherr et al., 2017; Abdelmeguid et al., 2022). The limited progress in CE adoption is attributed to a variety of barriers. The study of barriers and drivers to CE is recently ushering in a new stream of literature (Mont et al., 2017; Mishra et al., 2022; Kirchherr et al., 2018; Govindan & Hasanagic, 2018; Ritzén & Sandström, 2017; Molla et al., 2022; Rizos et al., 2016). Almost every scholar has identified collaboration as a critical driver, with several of them considering it as the key one (Toxopeus et al., 2017; Marke et al., 2020; Rajaeifar et al., 2022; Majumdar et al., 2022; Bressanelli et al., 2019; Ki et al., 2020; Dissanayake & Weerasinghe, 2022; Colucci & Vecchi, 2021; Mont et al., 2017).

While collaboration is identified as a critical driver, research on inter-organizational collaborations for CE is still sporadic and fragmented (Ingstrup et al., 2021). There is a lack of study on how

collaboration can be leveraged to promote the adoption of circular practices. Additionally, the existing studies on collaboration primarily focus on the intra-firm level or involve a limited number of actors. This has resulted in a call for richer case studies involving multiple actors to enhance a system-level understanding of collaborations for CE (Ingstrup et al., 2021; Aarikka-Stenroos et al., 2022).

Furthermore, many scholars (Ki et al., 2020; Ghisellini et al., 2016; Jia et al., 2020; Montag, 2023; Parida et al., 2019; Dissanayake & Weerasinghe, 2022; Konietzko et al., 2020; Roci et al., 2022; MacArthur, 2015) have argued that the study of the transition from a linear paradigm to CE requires the adoption of a system perspective that enables to analyze the complex interdependencies and interactions among all the relevant stakeholders. However, few academicians have used holistic approaches based on System Theory and System Thinking to study circular economic systems (Iacovidou et al., 2017), and it mostly happened at a conceptual level (Balanay & Halog, 2021). Therefore, to shed light on how collaboration can drive the adoption of CE, we adopt a holistic approach and conduct an empirical investigation in the textile industry.

1.1 Purpose And Research Question

This study aims to deepen the understanding of how collaboration can drive CE at the industry level by investigating the various types of collaboration that can be leveraged to adopt CE strategies and associated practices. By adopting a holistic approach, we aim to include the perspectives of every relevant stakeholder and enhance a system-level understanding of this phenomenon, thus avoiding any potential blind spot that may hinder the transition towards circularity. The research aims to fulfill this purpose by taking the textile industry as an empirical context and answering the following research question:

"How can collaboration drive the adoption of Circular Economy in Textile Industry?".

1.2 Expected Contributions

By studying how collaboration can drive the adoption of CE with a holistic approach, we aspire to contribute both to theory and practice. For theory, we aim (1) to contribute to CE literature by describing how various types of collaboration can facilitate CE adoption and introducing the concept of "circular lock-in." Moreover, we aim (2) to make a theoretical contribution to the Iacovidou et al. (2020) *System of Systems* conceptual framework by expanding it to study collaborative interactions and apply it in an empirical context, which, in our case, is the textile industry. For practitioners, (3)

the research is expected to help deploy a system perspective to understand how to use collaboration to drive CE and understand its system-level impact, which determines whether the practices become or not a norm.

1.3 Delimitations

Considering the viability of the research, we have introduced delimitations. Firstly, we delimited our study to only one context, namely, the textile industry. Although this choice allows for a deep and nuanced investigation of the industry selected, it may affect the transferability of the findings to other contexts. Secondly, while many interactions happen among different actors in an industry, we solely focus on collaborative interactions for CE adoption. Therefore, this research may overlook other significant interactions among actors that could be crucial in facilitating the transition toward CE and collaborative interactions for non-CE practices.

1.4 Thesis Outline

The thesis is organized in the following way (Figure 1):

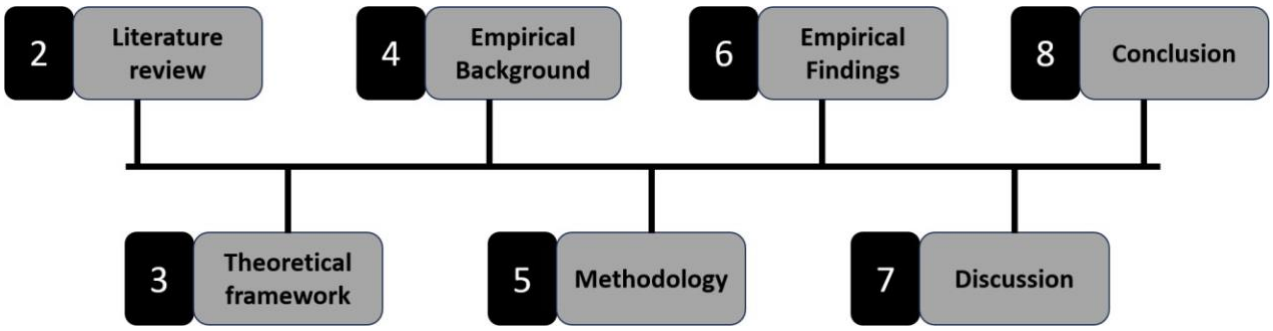

Figure 1: Thesis outline

2 Literature Review

2.1 From Linear to Circular Thinking

Human activity has always depended on the environment and its resources. Since the Industrial Revolution, we have witnessed an economic system dominated by the linear logic "take-make-dispose" (Franco, 2017). As visualized in *Figure 2*, in such logic, virgin resources are extracted from the environment, transformed into products, and finally disposed of in landfills (MacArthur, 2015; Pitt & Heinemeyer, 2015).

Figure 2: Linear economic system

CE scholars argue that this consumption model, also called cradle-to-grave, is inefficient since valuable inputs become worthless waste that often pollutes the environment (Dhonde & Patel, 2020; Kirchherr et al., 2017). Furthermore, this model is based on the irrational assumption that natural resources are unlimited (Franco, 2017; Ki et al., 2020). The irrationality of this model is not just environmental but also economic, given the escalation of the global resource scarcity challenges (Lieder & Rashid, 2016), with organizations increasingly exposed to supply chain risks and vulnerable to supply restrictions (MacArthur, 2015). This scenario could aggravate, considering that around 3 billion people will join the rank of the middle class by 2030, causing an upsurge in consumer demand.

Due to its potential for sustainable development, in the last decade, the CE has gained significant interest from policymakers and practitioners, and academic research has increased exponentially throughout the years (Ghisellini et al., 2016; Lüdeke-Freund et al., 2019; Mont et al., 2017; Montag, 2023). These interests include research on circular or regenerative product design (Bakker et al., 2014), product service systems (PSS) (Henriques et al., 2023; Tukker, 2015; Tukker & Tischner, 2006), remanufacturing and resource-conservative manufacturing (Ferrer & Ayres, 2000; Rashid et al., 2013; Roci et al., 2022), circular business models (Lüdeke-Freund et al., 2019; Mont et al., 2017; Rizos et al., 2016), circular supply chain management (Bressanelli et al., 2021; Farooque et al., 2019; Majumdar et al., 2022; Montag, 2023), industrial ecology (Erkman, 1997), and business ecosystems (Konietzko et al., 2020; Parida et al., 2019).

Despite becoming very popular only in the last decade, the concept of circularity is not novel (Lieder & Rashid, 2016). Like any multi-disciplinary field CE is rooted in and contains elements of previous paths of research within ecological economics (Costanza & Daly, 1987; Martinez-Alier, 1990), environmental economics (Pearce & Turner, 1990), industrial ecology (Erkman, 1997), remanufacturing (Ferrer & Ayres, 2000), product-service system (PSS) (Tukker & Tischner, 2006) and closed-loop supply chain (Govindan et al., 2015). Moreover, the CE domain is inspired by concepts such as Spaceman economy (K. E. Boulding, 1966), Cradle-to-Cradle (McDonough & Braungart, 2002), Blue economy (Pauli, 2010), and Resource conservative manufacturing (Rashid et al., 2013) to name a few. As previously mentioned, public institutions and policymakers are increasingly interested in circularity. One of the earliest examples is the "Circular Economy Promotion Law of the People's Republic of China," which became effective in 2009. More recently, the European Union has started producing policy recommendations regarding the adoption of CE practices (European Commission, 2020). Along with governmental actors, international organizations such as the UN and the OECD and NGOs such as the Ellen MacArthur Foundation have started raising awareness and producing recommendations to facilitate CE adoption at a systemic level (MacArthur, 2015).

The interest in this concept has led to numerous yet different definitions of CE. For this research, we choose the one by Kirchherr et al. (2017):

"*A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations."*

This definition brings together four crucial points to understand CE. First, it acknowledges the systemic nature of the transition from a linear to a CE (Iacovidou et al., 2020; Parida et al., 2019). As Konietzko et al. (2020) argue, circularity has to be considered a system property; for the transition to happen, the various market actors must engage in appropriate collaborations (Roci et al., 2022). Second, it comprehensively states how CE is about reduction, reuse, and recovery, while most of the policy has been focused only on recycling (Ghisellini et al., 2016), with the risk of incomplete adoption of circular practices. Third, a clear relationship between CE and sustainable development is

drawn. Indeed, only a minority of the definitions generated throughout the years take a holistic perspective on sustainability by including all three pillars (Kirchherr et al., 2017). Lastly, as opposed to most definitions, it explicitly considers future generations, thus making the long-term nature of CE explicit.

2.1.1 From Waste to Resource

In the past decades, the hegemony of the linear logic "take-make-dispose" has created the underlying assumption that waste has negative economic and cultural value, with people willing to pay to dispose of it (Amasuomo & Baird, 2016; Hawkins & Muecke, 2002; W. R. Stahel, 2013). However, as Dijkema et al. (2000) argue, labeling a substance as waste is relative to those who label it as such.

In such a context, the cultural exercise performed by CE is a change in the value perspective of waste (Song et al., 2015). Among the various concepts CE has drawn inspiration from, this change of perspective is mainly supported by the cradle-to-cradle concept (Linder et al., 2017), with one of the three core principles being 'waste equals food' (McDonough & Braungart, 2002). In a circular economy, waste is designed out by intention (MacArthur, 2015) through reusing, repairing, recycling, or recovering products and materials that, in a linear system, would be disposed of in landfills (Song et al., 2015). This approach creates an economic system less dependent on virgin resources (Prieto-Sandoval et al., 2018).

In the last 10 to 15 years, especially in Europe, the policymakers have focused on improving waste management practices, putting a stronger focus on waste prevention as opposed to treatment and explicitly mentioning how waste is a valuable resource (Wilson et al., 2015; Zacho & Mosgaard, 2016; European Commission, 2008). Despite this evolution, some scholars have argued that the resource management concept is more appropriate in CE because it considers waste as a resource with a positive value and adopts a systemic perspective (Williams, 2014; Wilson et al., 2015; Wilts et al., 2016). Furthermore, adopting a resource management perspective allows us to introduce the concept of leakage, which classifies the resources that leave the loop as a loss. One of the main goals of CE practices is to minimize the leakage of materials out of the system (MacArthur, 2015, 2017). Therefore, resource management is an essential complement to waste management to minimize leakages and close the resource loop.

2.1.2 Circular Economy Practices and Strategies

Practitioners, scholars, and policymakers have proposed several frameworks, such as the 3R (Ghisellini et al., 2016), 4R (European Commission, 2008), and 9R framework (Potting et al., 2017), all following the same logic with the first R preferred to the second R and so forth. Despite their different level of detail, they all originate from the waste hierarchy framework (European Commission, 2008; Kirchherr et al., 2017; Lansink, 2018). This framework defines (1) prevention and (2) reduction as preferred options, followed by (3) reuse and (4) recycling. The last two options, (5) recovery and (6) disposal in the landfills, are the least preferred. The latter option is incompatible with CE since it does not respect the principle of maintaining resources in the economic loop and has a potentially negative impact on the environment and human health.

To distinguish circular from linear economy, we align with Bocken et al. (2016) and present three main CE strategies. In addition to Bocken et al. (2016), we categorize the waste hierarchy practices into the three strategies, as shown in the Table 1.

Table 1: CE strategies

Strategy	Description	Waste hierarchy practices
Narrowing	This strategy aims to narrow the resource flows in order to use fewer resources per unit of output	(1) Prevention; (2) Reduction
Slowing	This strategy aims to extend and/or intensify the use phase of a product, thus slowing down the resource flow and reducing the amount of resources flowing throughout the system through the design of long-life products and product-life extensions (e.g., service loops such as repairing)	(2) Reduction; (3) Reuse
Closing	This strategy aims to concretely close the resource loop by reintroducing into the system what in a linear economy is considered useless waste and disposed of in landfills, thus creating a circular flow of resources	(3) Reuse; (4) Recycling

Despite the increasing effort from various societal actors, such as scholars, policymakers, and practitioners, the level of adoption of circular practices is still low (Abdelmeguid et al., 2022; Ki et al., 2020; Kirchherr et al., 2018). The acknowledgment of this say/do gap made us curious about the reasons behind it, whose understanding is fundamental to have a complete picture of the current situation. Scholars have attributed this limited progress to a variety of barriers, with a growing specific literature focusing on various industries and geographical contexts (Govindan & Hasanagic, 2018; Kirchherr et al., 2018; Mishra et al., 2022; Molla et al., 2022; Mont et al., 2017; Ritzén & Sandström, 2017; Rizos et al., 2016), and several studies that have explicitly addressed the textile industry (Dissanayake & Weerasinghe, 2022; Franco, 2017; Jia et al., 2020; Kazancoglu et al., 2020; Ki et al., 2020; Ponnambalam et al., 2023; Saccani et al., 2023). For a better overview of the most common barriers to CE presented in the literature, please refer to *Appendix 10.1*.

2.2 Collaboration as a Major Driver

In the extant literature on CE drivers and barriers, nearly every scholar addresses collaboration among value chain actors as an essential driver. Conversely, the absence of such collaboration is identified as a significant barrier. For example, Toxopeus et al. (2017) suggest how the actions required to close material loops transcend the boundaries of single companies, thus requiring close collaborations among the relevant actors in the value chain. Marke et al. (2020) and Mont et al. (2006) highlight how collaboration within the value chain is crucial for the successful implementation of circular business models based on leasing and product remanufacturing. Rajaeifar et al. (2022) also extend the needed collaboration dynamics to actors not primarily involved in the value chain, such as academia, while Lang et al. (2023) highlight the importance of consumers' collaborative behaviors. Bressanelli et al. (2021) address partnership, collaboration, and cooperation as fundamental levers to move from linear to circular business, confirming their previous study by Bressanelli et al. (2019), where they suggest how close partnerships among supply chain actors can solve the various CE challenges. Focusing on the textile industry, Ki et al. (2020) conducted a systematic literature review about CE and concluded that collaboration is vital for adopting circular business models. Dissanayake and Weerasinghe (2022) conducted a systematic literature review in the field of circular fashion and suggested how extensive commitment, communication, and engagement among all the actors is needed. They concluded that a shift toward a system perspective and a collaborative mindset is required for CE transformation. After studying a project for the reuse of textile fibers executed jointly by a consortium of universities and industry, as well as public actors, Martina and Oskam (2021)

conclude that for a recycling business model to become viable, collaboration among private, public, and civil society is needed.

Furthermore, in a recent case study of a Swedish fashion retailer, Sandberg (2023) found that collaboration is crucial for an ecosystem of actors to successfully implement circular practices. Case studies on specific geographical markets confirm the findings mentioned above; for example, Huang et al. (2021) found that collaboration is a major driver in the transition of the Taiwanese textile sector towards CE. The same conclusion is drawn by Colucci and Vecchi (2021) in their study of the Italian fashion industry. Finally, of particular interest is a recent study from Majumdar et al. (2022) on the barriers to CE implementation in the Indian textile industry. In this study, the authors consulted numerous industry experts and then ranked lack of collaboration as the most prominent barrier to circularity.

2.2.1 Collaboration for CE

While collaboration is considered a fundamental driver, research has only recently and sporadically studied inter-organizational collaborations in CE (Ingstrup et al., 2021). Furthermore, the existing body of literature appears to be fragmented in different research streams (Aarikka-Stenroos et al., 2022), such as production and manufacturing (Govindan & Hasanagic, 2018; Bressanelli et al., 2019; De Angelis et al., 2018), supply chain, operations, and logistics management research (Farooque et al., 2019; Hazen et al., 2021; Majumdar et al., 2022; Montag, 2023; Saccani et al., 2023), sustainability and CE research (Lüdeke-Freund et al., 2019; Mont et al., 2017). Within these research streams, a notable focus is on collaboration in diverse areas, including reverse logistics and closed-loop supply chains. Additionally, emphasis is placed on collaborative product design aligned with CE principles and collaborations with suppliers to manage material flows and minimize waste at every stage of the supply chain. Collaboration extends to implementing business models based on servitization and forming partnerships to engage new stakeholders necessary for transforming the current supply chain into a circular system. Moreover, collaborative efforts are directed towards developing suppliers' capabilities to enhance CE initiatives across the supply chain and engaging Customers through communication practices designed for educational purposes.

These studies on collaborative dynamics for CE have been predominantly conducted by taking the perspective of the supply chain and its actors, thus considering less, or not considering, other vital actors that are external to the supply chain studied, such as the civil society (e.g., NGOs) and public

institutions (e.g., government). At the same time, data are usually gathered, and consequently studies are conducted, from individual organizations' perspectives, with authors such as Aarikka-Stenroos et al. (2021) and Aarikka-Stenroos et al. (2022) calling for more prosperous case studies, with data from multiple supply chain's actors but also surrounding stakeholders, which would enhance a system-level understanding of inter-organizational collaborations for CE. Finally, as per our knowledge, research has yet to address the different types of collaboration suited to drive CE strategies. Still, the term collaboration has been primarily used in a generic way.

2.3 Concluding Remarks

In the previous sections, we reviewed the extant literature on CE, in the attempt to shed light on its meaning and practices. Following, we highlighted the importance of collaboration for CE adoption, underlining a gap in the current literature.

In agreement with numerous scholars (Dissanayake & Weerasinghe, 2022; Ghisellini et al., 2016; Jia et al., 2020; Ki et al., 2020; Konietzko et al., 2020; MacArthur, 2015; Montag, 2023; Parida et al., 2019; Roci et al., 2022; Schröder et al., 2019; Alhawari et al., 2021), we argue that comprehending the transition from a linear to a circular economy necessitates adopting a systemic perspective. Therefore, we require a theoretical lens and framework that provide a holistic view while allowing for a certain degree of granularity to conduct an adequate analysis. In the next section, we introduce our theoretical lens and framework. Subsequently, we will introduce our empirical context and illustrate its potential for valuable study.

3 Theoretical Framework

3.1 Holism VS Reductionism

By analyzing the literature on CE, it is possible to distinguish two lines of thought influencing how scientific research about this topic has been carried out: reductionism and holism (Balanay & Halog, 2021). *Reductionism* is based on the idea that something big can be subdivided into manageable parts with the underlying assumption that the whole corresponds to the sum of its parts (Balanay & Halog, 2021). It is an approach based on a silo-thinking logic that, in the pursuit of tractability, clarity, and simplicity, can lead to dangerous blind spots, which usually represent the unintended outcomes of development interventions (Anastas, 2019; Skene, 2018; Korhonen et al., 2018). If not accounted for, unexpected negative outcomes can cause CE adoption to slow down. Alternatively, *holism* is a more suitable approach to study CE as it considers the underlying links and interdependencies needed to understand how CE adoption can be driven (Balanay & Halog, 2021). Indeed, holistic approaches allow for a system-level analysis necessary to understand the positive and negative feedback loops that follow CE adoption (Bassi et al., 2021), informing stakeholders about potential drawbacks and thus facilitating accurate evaluations (Muth et al., 2019).

3.1.1 Holistic Approaches

Since the development of Aristotle's Holism, based on the claim that knowledge arises from the understanding of the whole and not that of the single parts, a stream of research focused on defining and understanding systems, their parts as well as relative dynamics, developed (Mele et al., 2010). This mode of thought evolved during the last century into the so-called "Systems theory" (Boulding, 1956; Von-Bertalanffy, 1956; Meadows, 2008), an interdisciplinary theoretical field encompassing every system in nature, society, and many scientific domains such as chemical and biological disciplines, information technology, sociology, philosophy and so forth (Mele et al., 2010). Applying the lens of Systems theory means using a framework to study phenomena with a holistic approach, called System thinking (Balanay & Halog, 2021). Indeed, we cannot comprehensively understand a phenomenon by individually studying its elementary parts, given the assumption that the whole does not merely correspond to the sum of its parts (Balanay & Halog, 2021). These parts are rationally connected toward a common aim (Golinelli & Momigliano, 2009). Thus, we can understand a phenomenon only by looking at it from a system perspective. As Mele et al. (2010) argue, a systems

theory is a perspective that studies a phenomenon, focusing not only on the elementary parts but especially on the interactions and relationships among them.

Von-Bertalanffy, (1956) in building the so-called General Systems Theory (GST), defines a system as a complex mix of interacting elements. We can find other definitions of a "system" throughout the literature. For instance, Churchman (1979) defines a system as a "structure with organized components", Boulding (1985) as "anything that is not chaos", while Boardman and Sauser (2006) "a collection of entities and their interrelationships gathered to form a whole greater than the sum of the parts". Despite different definitions, the shared motif is that a system comprises elements, forming an integrated whole to achieve some purpose (Caddy & Helou, 2007). Moreover, systems interact and are influenced by their environment and other systems (Ackoff, 1981). Another foundational idea regards the interactions among components. As Mele et al. (2010) explain, the individual components behave differently when interacting with other components in the system compared to how they would behave without those interactions. Another fundamental principle is introduced by Yourdon (1989) and further elaborated by Caddy and Helou (2007) in their application of GST to the supply chain domain, namely the decomposition principle. Every system can be decomposed into subsystems, which in turn can be decomposed into other subsystems and so on, with these subsystems interacting with each other.

As previously mentioned, this research stream is highly heterogeneous and transdisciplinary, with different approaches generated from GST, such as Open System Theory (OST), Viable System Model (VSM), and Viable System Approach (VSA). Several authors have implicitly or explicitly studied organizations as systems, specifically within management and marketing domains. Building on the work by Beer (1972), the Viable System Approach (VSA) has been developed and applied to managerial studies by making a distinction between subsystems, with focus of analysis on the relationships among the internal components of the firm, and suprasystems, with focus on the interconnections between firms and other entities in their environment (Barile, 2008). Applying GST to the supply chain domain, Caddy and Helou (2007) argue that a supply chain can be defined as a system and, through this lens, give a deeper understanding of supply chains and their management. Studying business value creation, Mele et al. (2010) distinguish between value created in the subsystems (e.g., R&D activities, quality management practices, internal auditing, etc.) and value created through cooperation with other systems, such as other firms in the supply chain or network.

3.1.2 Systems Thinking Approach for Sustainability Management

Management scholars have long recognized that the complexities of the sustainability challenges demand a system approach. This involves considering social systems as nested within the natural system and being conscious of the dependencies of business on nature (Gladwin et al., 1995; Marcus et al., 2010; Roome, 2012; Starik & Rands, 1995). Whiteman et al. (2013) argued that scholars and managers should consider the dynamic interactions within and across the interconnected systems to address pressing issues like climate change, social inequality, unemployment, and ecological degradation.

The past decade witnessed the emergence of many theories, frameworks, and strategies to facilitate systems thinking to promote sustainability. Few of the theoretical influences that are directly related to CE, like cradle-to-cradle (McDonough & Braungart 2002), performance economy (W. Stahel, 2010), industrial ecology (Erkman, 1997), industrial symbiosis (Chertow, 2000) provide context and guidelines to improve resource efficiency and management at the sectoral and national level. However, they fail from a system lens as they do not provide a multi-dimensional perspective on value creation, dissipation, and destruction in complex social, economic, and political contexts (Iacovidou et al., 2020). Few academicians have taken the lens of Systems theory, and thus of System thinking, to study CE. Iacovidou et al. (2017) evaluated the methods within CE literature and argued that most existing ones fail to accurately represent the complexities, trade-offs, and impacts of a system intended to promote circularity. As per our knowledge, Iacovidou et al. (2020) made one of the first attempts in this direction by developing a theoretical framework for studying CE from a system perspective.

Furthermore, as we realized during our literature review and further confirmed through the work of Balanay and Halog, 2021), the adoption of System thinking has mostly happened at a conceptual level. We argue that this has been, and still is, a potential barrier to this approach's widespread adoption and its ability to contribute concretely to tackling complex social problems such as those related to sustainability and CE. Therefore, we follow the suggestion of scholars such as Balanay and Halog (2021), Pieroni et al. (2020) and Jaspers (2019), and we consider reductionism as complimentary to holism, thus borrowing from reductionism the strategy of empirically determining the elements to be put together to constitute a dynamic whole. In the next section, we will present the conceptual framework by Iacovidou et al. (2020) and subsequently extend it to answer our research question.

3.1.3 System of Systems

Iacovidou et al. (2020) model consists of a system constituted by three core interconnected subsystems: *Processes*, *Actors*, and *Values*.

The *Processes* subsystem involves the flow of resources across all the activities from production to consumption to End-of-life (EOL) management. These activities involve reverse logistics, feedback for reuse, remanufacture, recycling, and so forth.

The *Actor*s subsystem comprises all the stakeholders involved in the system. Some actors are internal, thus directly involved (e.g., manufacturers, retailers, et cetera), while others are external, thus indirectly involved (e.g., government, NGOs) in the value chain. The *Actors* influence the *Processes* in their various forms (production, consumption, End-of-Life management).

The *Values* subsystem refers to the positive and negative impacts in the environmental, economic, social, and technical domains as influenced by the respective processes and stakeholders' perceived needs, concerns, and other considerations. These values can provide critical insights into cause-and-effect relationships of circular systems and reflect the potential of driving change.

These three subsystems function as a whole within the boundaries of the system, and their behavior affects the entire system. These boundaries can be space-specific (e.g., city, country, ecosystem, organization), resource-specific (e.g., material, component, product), process-specific (e.g., paper pulp manufacturing, plastic waste reprocessing), or a combination of these. Moreover, the authors used the 'System-of-Systems' (SoS) concept to apply, in their model, the co-evolutionary framework by Foxon (2011). This co-evolutionary framework is a dynamic web of subsystems that have both synergies and an impact on each other and on the system. Such a framework is adopted by Iacovidou et al. (2020) and applied to form the landscape or surroundings where their system is situated. The surroundings consist of Natural environment and provisioning services; Technologies, infrastructure, and innovation level; Governance, regulatory framework, and political landscape; Activities performed by businesses and the market; and patterns of behavior relating to human and societal needs.

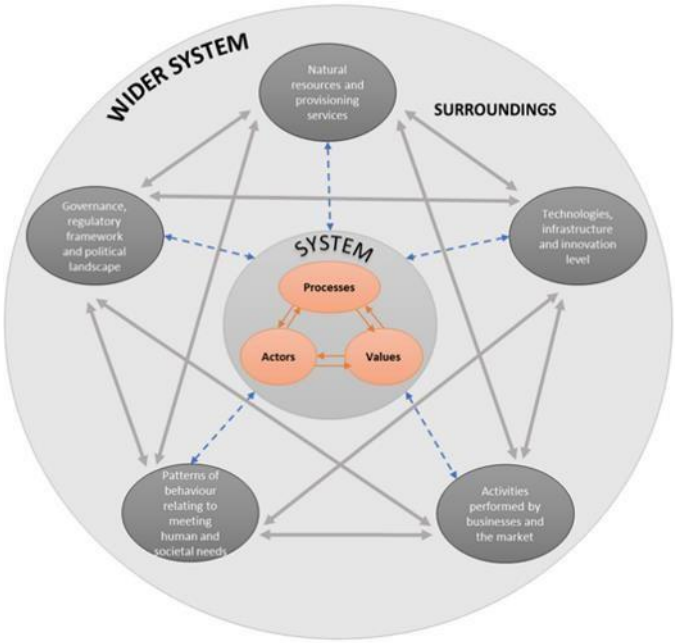

Figure 3: System of Systems (Iacovidou et al., 2020).

3.2 Collaborative Governance

The complexity of wicked social problems, such as sustainability, demands the collaboration of multiple stakeholders with different resources and know-how to propose and implement effective solutions (Perzon, 2021). Collaborative governance mechanisms refer to the specific types of collaboration used by multiple actors to align their efforts toward shared goals.

Pattberg and Widerberg (2016) analyzed 340 partnerships for sustainability and noted that 211 failed to achieve their objectives or became inactive shortly after their initiation. The authors argue that inappropriate collaborative governance structures exacerbated problems such as inadequate funding, wrong partner mix, ineffective leadership, and improper fit-to-problem structure. Similarly, Vazquez-Brust et al. (2020) point out that many private-sector-led collaborations for sustainability tend to follow a one-size-fits-all approach in choosing the type of collaboration. Authors like Husted and Sousa-Filho (2016) noted that while acknowledging collaboration as the key to approaching sustainability problems, many studies do not differentiate among the different types of collaboration but address it in a generic way. Some authors have tried to add more detail in discussing collaboration for sustainability and CSR practices. Golini and Gualandris (2018) differentiate between modular, relational and captive types of collaboration based on the power disparity among the parties involved and how it is exercised to drive the collaboration's modes and goals. Walther et al. (2008) studied

collaboration based on the level of central coordination of collaborations, while Formentini and Taticchi (2016) distinguished collaborations based on the rules of engagement.

Table 2: The different types of collaboration based on three dimensions - Formality, Hierarchy, and Centrality.

Dimension	Type of collaboration	Description
Formality	Formal	Collaboration arrangements based on comprehensive and detailed contracts that rule all aspects of collaboration
	Informal	Collaboration arrangements based onpersonal links, common interests, common values or non-written, tacit rules and agreements
Hierarchy	Captive	Collaboration arrangements where a dominant and more powerful partner defines and closely monitors rules and processes
	Relational	Collaboration arrangements where partners have similar power and switching costs and define rules jointly through frequent interaction, trust, and shared experience
	Assessment-based	Sit between relational and captive
Centrality	Centralized	Collaboration arrangements where the interactions are coordinated through a central hub
	Decentralized	Collaboration arrangements where the interactions are coordinated through ad-hoc arrangements between the parties

Still considering the field of collaborations for sustainability as a “black box” Vazquez-Brust et al. (2020) aligned the current literature and defined three main dimensions of collaboration from which it is possible to distinguish among different types of collaboration, as displayed in Table 2.

We incorporate these three different dimensions with the respective types of collaboration postulated by Vazquez-Brust et al. (2020) in our theoretical framework as a lens to study the collaborative interactions among various textile industry stakeholders.

3.3 Theoretical Synthetization

To answer our research question, we need a framework that takes a systemic perspective with the necessary granularity to analyze collaboration dynamics and studies how collaboration might affect CE adoption. We combine the concepts from CE literature and collaborative governance and extend the Iacovidou et al.'s (2020) System of Systems to develop our framework (Figure 4). The framework's collaborative dynamics element helps us bring more granularity while analyzing the collaborative initiatives for CE in the *Actors* subsystem. The CE literature provides the necessary concepts to analyze CE adoption in the *Processes* subsystem.

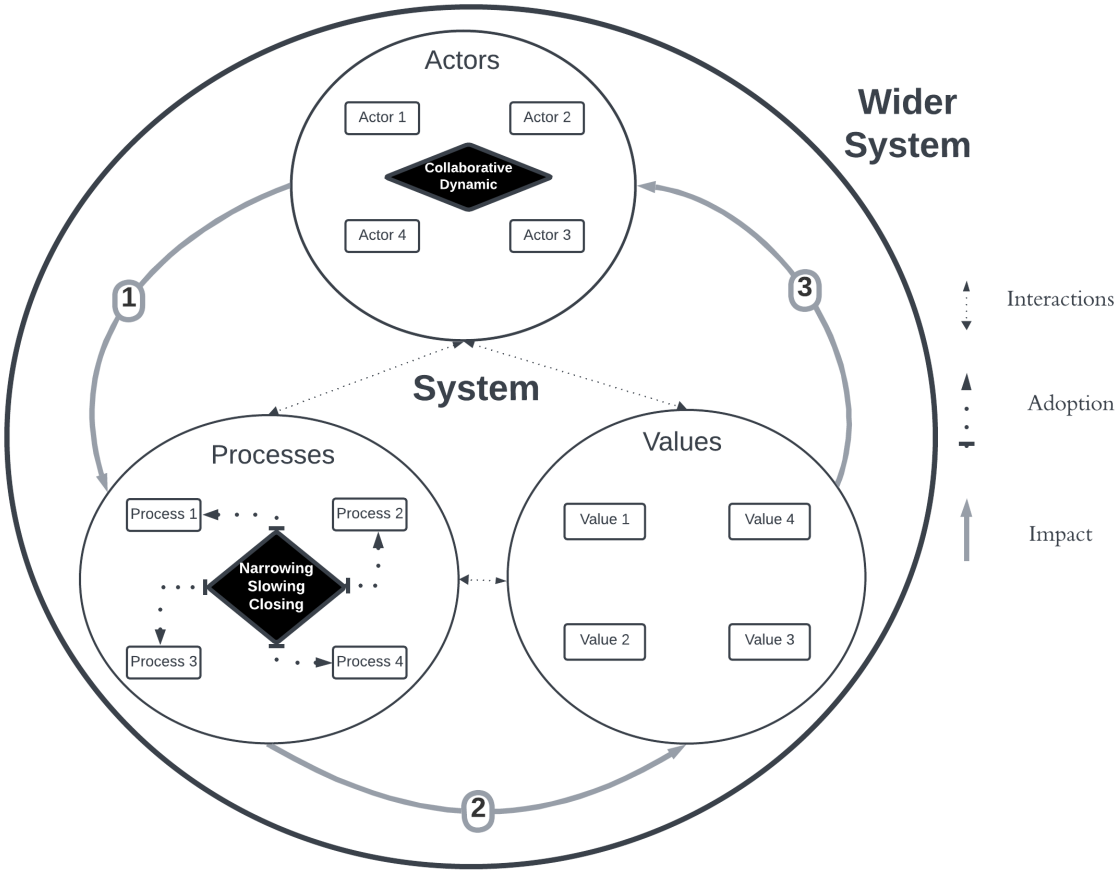

Figure 4: Theoretical Framework

In the subsystem of *Actors*, we study the different types of collaboration dynamics among actors. We then investigate how different types of collaboration among actors can drive CE adoption in the *Processes* subsystem. The bold dotted arrows in the *Processes* subsystem represent the adoption of CE strategies and associated practices in the various processes. While taking a holistic view, we need to study the impact of this adoption on the *Values* subsystem as well, which in turn impacts the *Actors* subsystem by providing the actors with feedback on their actions.

The theoretical framework allows us to analyze our research question further, *"How can collaboration drive the adoption of Circular Economy in Textile Industry?"* and organize our investigation into two parts, which are necessary to provide a holistic and comprehensive answer. First, we investigate the impact of collaborative dynamics on CE adoption (1). Second, we investigate the impact of the adoption of CE strategies on the *Values* subsystem (2) and, subsequently, the impact of *Values* on the *Actors* subsystem (3). Analyzing all the gray arrows (1), (2), and (3) is necessary to gain a holistic view.

The dotted arrows represent all the other potential interactions among subsystems, which are outside the scope of this research. Moreover, given this research's limited scope and time, we do not focus on the wider system in the Iacovidou et al. (2020) System of Systems conceptual framework presented in (3.1.3).

4 Empirical Background

The main objective of this chapter is to introduce textile industry and to discuss its main characteristics.

The term “textiles” defines all the products that contain knit or woven textile components and concerns primarily apparel and footwear but also home, technical, medical, and automotive textiles. The Textile and Apparel (T&A) value chain comprises five major stages: (1) Fiber production, (2) Yarn production, (3) Textile production, (4) Consumption, (5) End-of-life. The actors engaging in each of these stages are spread all over the world because of the global character of this value chain. Figure 5 represents the actors and the stages of the textile value chain. The textile industry is organized in such a way that the production activities are located primarily in Asian countries such as China, Bangladesh, India, and Vietnam (ILO, 2021), while the majority of the retail brands, which control the high-rent activities such as design, distribution, marketing, and retailing are situated in the USA and Europe (Gereffi, 1999; Kaplinsky, 2005; Azmeh & Nadvi, 2014). The low-cost and low-return functions (e.g., production) are often achieved by employing low-cost, decentralized production networks, mainly in the developing countries mentioned above (Euratex, 2017; Gereffi, 1999; Kaplinsky, 2005; Azmeh & Nadvi, 2014). Brands are the dominant players in the chain and have a demand-pull relationship with their suppliers. Moreover, the informal sector plays a significant role in the textile value chain, especially in the production stages.

The T&A industry plays a crucial role in contributing to the advancements of economies, particularly emerging ones, by increasing export revenue, augmenting employment opportunities, and improving living standards (Euratex, 2017). The global T&A trade achieved a substantial value of US$807 billion and engaged over 70 million individuals throughout its supply chain (World Trade Report, 2019; Saha et al., 2021). The T&A industry is the third largest manufacturing industry in the world, with an estimated value of US$1.3 trillion (House of Commons Environmental Audit Committee, 2019).

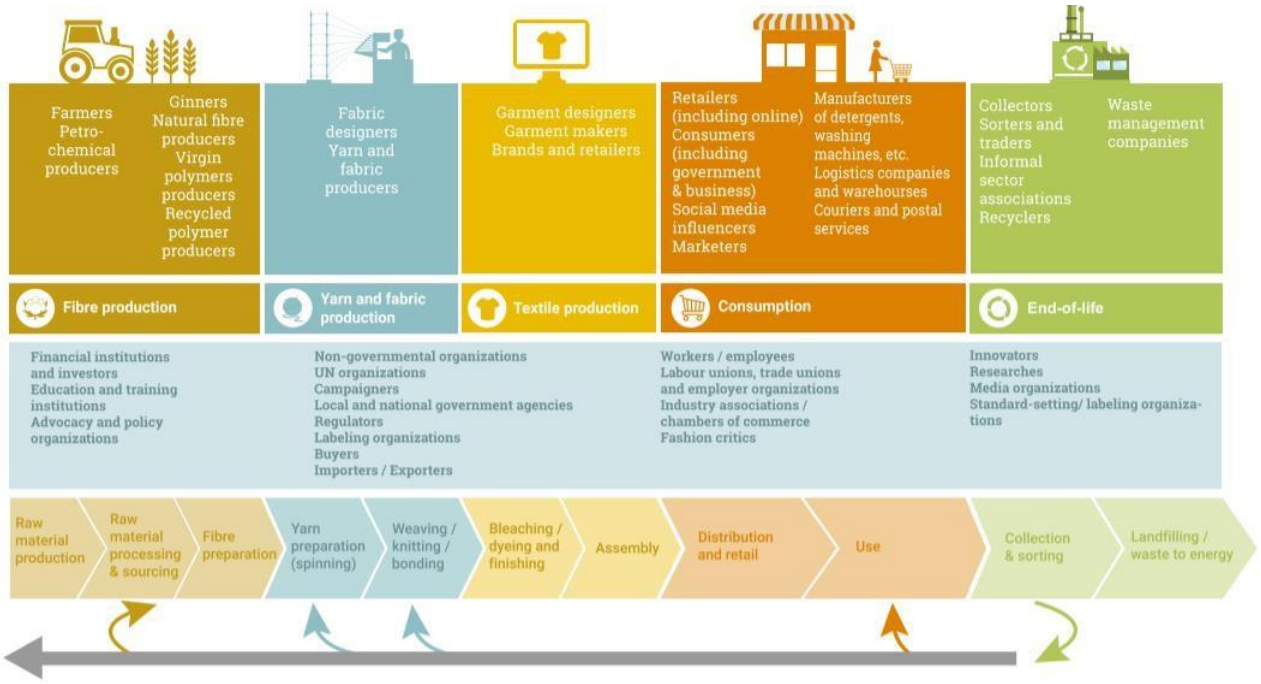

Figure 5: Stakeholders associated with the textile value chain, UNEP (2020)

4.1 The Dark Side of the Textile Industry

While the T&A industry is crucial in the global economy, it is historically plagued by social and environmental unsustainable practices. As companies move into new low-cost countries with limited capacity to implement laws and regulations, and with the pressure on profitability, working hours, and wages that new technologies bring, there is a high risk that fundamental principles and rights of workers may be denied. Moreover, the growing number of young, unskilled women and men in developing countries will likely lead to an increasing proportion of vulnerable workers (ILO, 2019). The industry is notorious for its substantial energy, water, and natural resource consumption (Gupta & Gupta, 2020; Islam et al., 2021). One of the primary reasons for drying the North Aral Sea in Uzbekistan has been cotton production to feed the global clothing demand, leading to the displacement of communities and the destruction of marine life (White, 2014). The T&A industry generated 92 million tons of waste in 2014, and only a negligible share of this was subjected to reuse or recycling, while the rest ended up in landfills (Pensupa et al., 2017; Niinimäki et al., 2020). The MacArthur Foundation (2017) reported that the greenhouse gas emissions from textile and apparel production exceed the combined emissions from aviation and maritime transport. Furthermore, it forecasted that the industry will use more than 26% of the carbon budget by 2050 if the status quo of

the industry practices does not change (MacArthur Foundation, 2019). Figure 6 represents the climate impact across the global apparel value chain as captured by UNEP (2020).

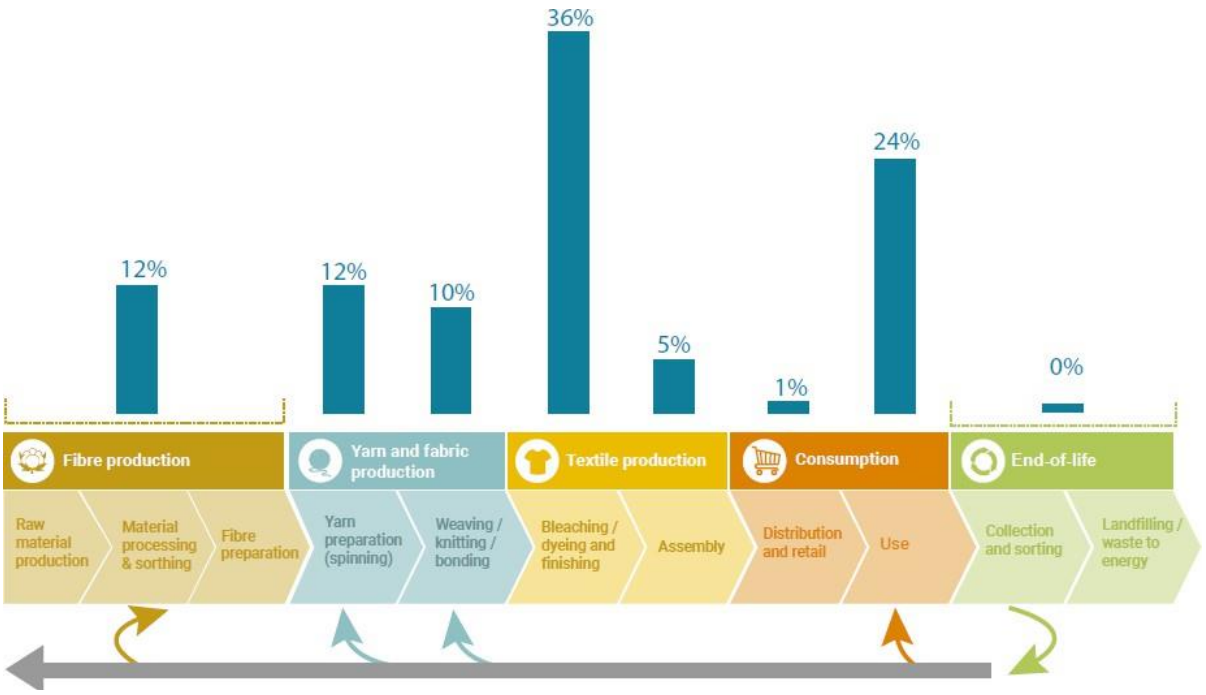

Figure 6: Climate impact across the global apparel value chain, (UNEP 2020)

As per the UNEP (2020) report, the textile value chain is estimated to be responsible for between 2% and 8% of global greenhouse gas (GHG) emissions, as well as significant pollution, water extraction, and biodiversity impacts, including 215 trillion liters of water consumed per year and 9% of annual microfiber pollution to oceans. Furthermore, the future projections do not depict an optimistic scenario. The surge in demand and fashion trends will further aggravate the situation (Sobuj et al., 2021). The latter has resulted in an almost 50% increase in clothing production and around 40% drop in the number of times the clothes are used (Atstāja et al., 2021; Wiederhold & Martinez, 2018).

4.2 Call for Sustainable Textile

The fashion industry is a major contributor to environmental degradation. While many initiatives are underway to address this problem, the industry is still expected to miss the 1.5°C pathway outlined in the Paris Agreement by 50%. Ethical fashion consumption and sustainable raw material production are not enough to tackle this issue (Joy et al., 2012; Laari et al., 2016), and a transition from a linear to a circular model is necessary (IPCC, 2022; Jia et al., 2020).

5 Methodology

5.1 Methodological Fit

To answer our research question properly, a qualitative approach appears ideal for three main reasons. First, our study intends to shed light on a relatively new phenomenon that has yet to receive much attention in the literature. Therefore, a qualitative approach that allows the collection of rich, detailed, and evocative data while remaining open to unexpected input from the field seems to be the most suitable (Edmondson & McManus, 2007). Second, to close the gaps related to the lack of empirical investigation and system perspective, we conducted part of our data collection in a developing economy to include in our sample significant value chain actors whose perspective has been little considered in previous literature (Saha et al., 2021). Thus, given the geographical distance, using methods such as an online-based quantitative survey would have introduced concerns about sampling accuracy and reliability, and it would not have allowed us to capture the nuances and the deeper meanings of the issues (Saha et al., 2021). Indeed, establishing empathic relationships through face-to-face interaction was necessary to make participants comfortable sharing sensitive data about their processes, relationships, and opinions (Lofland & Lofland, 1995). Third, our chosen theoretical lens stresses the importance of studying phenomena by including the perspectives of the various system actors in the same study. A qualitative research design enabled us to elucidate the empirical nature of collaboration dynamics and CE strategies and their impact on the textile industry through detailed descriptions of actors and their interactions and generate knowledge through interpretations of their insights, perspectives, and analyses (Bell et al., 2022).

5.1.1 Research Philosophy

We must consider our ontological assumptions in light of our ambition to contribute theoretically and practically to this research. Indeed, understanding the latter is a necessary step in designing a research study that will allow us to effectively capture the reality we aim to understand (Bell et al., 2022; Saunders et al., 2012). Our stance with respect to the nature of reality is defined as social constructivist ontology. We contemplate reality as shaped and socially negotiated through social actors' interrelations and interactions, thus in a constant state of revision (Guba & Lincoln, 1985). This ontological stance aligns with scholars who have applied system theory and system thinking to study CE (Iacovidou et al., 2020). Following this ontological stance, epistemologically, we adopt an interpretive position as we study reality by viewing it from the system actors' point of view (Bell et

al., 2022). This position complements our investigation from a system perspective, in which we aim to simultaneously understand and synthesize the perspective of the various system actors.

5.1.2 Research Approach

Another essential methodological choice concerns the relationship between theory and empirics. A popular approach in business research is called abductive, which stands between induction and deduction (Bell et al., 2022). The abductive approach allows for a parallel and continuous dialogue between empirical evidence and literature, thus allowing the researcher to remain receptive to possible surprises in data rather than using it only to confirm previous literature (Alvesson & Kärreman, 2007). An abductive approach starts with a puzzle, something surprising, and then seeks to explain it. Our research process began with the participation in a co-creation workshop on CE at the 7th joint Nordic Development Research Conference (NorDev), where we realized how CE adoption was hindered by many barriers involving actors in Europe and developing economies (see *Appendix 10.2* for a detailed description of the workshop). Then, we conducted a pre-study along with a literature review which informed the development of our theoretical framework. Informed by this theoretical background, we entered the data collection phase. The data collection enriched our framework through a back-and-forth engagement with the literature and, finally, after careful analysis, led to our contributions (Alvesson & Kärreman, 2007). This approach was considered suitable also given our choice of conducting a qualitative study and the gap that was of both empirical and theoretical nature; thus, abductive reasoning provided us with the potential of creating knowledge by iterating between theory and empirics (Saunders et al., 2012).

5.2 Research Design

Since the beginning of our research, we have been interested in CE due to its potential for sustainable development. Following an iterative learning process, we narrowed our research scope and focus. The investigation was limited to the textile industry, acknowledging the drawback of potentially reducing the opportunities to generalize outside this context (Bell et al., 2022). On the other side, the case study method allows to dive deep into real-life dynamics, experiences, and perceptions related to the phenomena under study, and it is considered particularly suited to “how” questions (Yin, 2014); therefore, a case study was deemed appropriate by the authors to shed a relevant light that goes beyond generically addressing collaboration as a driver for CE adoption. Furthermore, such an approach allows us to consider contextual factors pertinent to the textile industry, such as its global nature, with

manufacturing mainly happening in developing economies (Yin, 2014). Also, as Yin (2013) argues, case studies are suited when the researcher aims to study an emergent phenomenon, such as CE. Indeed, CE is progressively gaining interest from practitioners, legislators, and academia, given its potential to make unsustainable industries more eco-friendly. Through several publications, the EU indicates a path towards transitioning from a linear to a circular model in business and society, with the textile industry considered a priority (European Commission, 2022). The textile industry is one of the most polluting, with CO2 emissions that will steadily increase if the linear status quo does not change. Therefore, it represents an exciting industry to study and where contributions can be made both to academia and practitioners.

5.3 Data Collection

Our qualitative study included one pre-study and one main study. The pre-study was conducted in Sweden (15/09-20/09), while the main study was performed in Sweden (21/09-30/09) and India (2/10-24/10) and involved interviews and field visits. In India, we specifically visited Noida, Gurugram, two industrial hubs on the outskirts of New Delhi. Then, we visited Tirupur, also called the knitwear capital of India, which is situated in Tamil-Nadu in the south of the country.

5.3.1 Sampling

In order to collect adequate data to best inform our study, we adopted a purposive sampling approach. The knowledge and awareness acquired through our literature review and the pre-study guided us in establishing the main study's criteria for selecting relevant participants at the outset. Thus, we adopted a priori purposive sampling (Bell et al., 2022). Criteria for inclusion in the study were based on (i) full-time employment in an organization that directly or indirectly influences the adoption of CE practices in the textile industry; (ii) involvement in strategic decisions regarding sustainability; (iii) diversity, where we aimed at obtaining the perspective of different actors directly or indirectly involved in the textile system; (iiii) geographical diversity, where we aimed at including the perspective of actors in an essential developing economy for textile production such as India. As Bell et al. (2022) highlight, purposive sampling often involves multiple approaches. Indeed, we also adopted some snowballing as we identified a couple of initial contacts that helped us to reach other relevant actors. The snowballing approach evinced importance in three ways. First, it enhanced the access to interviewees, especially in India, given the relationship between the advisor and the advised (Noy, 2008). Second, it permitted access to high-profile individuals, such as managers, owners, and

government officials. Third, it allowed us to investigate a potentially sensitive topic due to the indirect trust towards us enabled by the advisor of the interviewees. This process resulted in a final sample with interviewees representing brands, textile manufacturers, textile associations, recyclers, public business institution, NGOs, venture capitalists, embassy, and consulting companies.

However, the number of interviews was not established a priori; instead, we adopted the model of data saturation (Saunders et al., 2018). After the 28th interview, new data started to repeat what was expressed in previous data, a situation called ”informational redundancy“, with no new codes emerging. Nonetheless, as Crouch and McKenzie (2006) suggest, we decided to go beyond the point of saturation to ascertain that the emergence of new data was depleted. Therefore, we conducted 2 additional interviews. These additional interviews made us confident to have reached the saturation point. Ultimately, we collected secondary data such as presentations, company reports, industry reports, and manufacturing reports from the various actors directly from them or their company websites and industry newspapers.

5.3.2 Semi-structured Interviews

Following Rubin and Rubin (2012) we adopted the principle of responsive interviewing, which entails the willingness to obtain the interviewees’ perspectives on their living and working environment through a collaborative conversation, which comprises being attentive to non-verbal cues and inconsistencies in the answers. This technique is compatible with semi-structured interviews based on an interview guide composed of open-ended questions with the possibility of deploying probing techniques and making follow-up questions, thus ensuring an exhaustive understanding of the interviewees’ viewpoints (Adeoye-Olatunde & Olenik, 2021; Bell et al., 2022). Furthermore, it favored greater flexibility throughout the process, which was appropriate considering the sensitive nature of the themes touched upon by our research. Such flexibility enabled us to discern which factors were most important to the participants, allowing us to shape the conversation accordingly. This resulted in the discussion touching on controversial and sensitive themes that would not have otherwise emerged. Therefore, we identified semi-structured interviews as the most appropriate tool.

5.3.3 Pilot Study

A pre-study with 2 industry actors was conducted to assess our research's practical relevance and test our interview guide. These interviews enhanced our understanding of the textile industry and its processes, thus allowing us to enter the main study prepared to sustain technical conversations. In

addition, it gave us important insights to improve our interview guide (Van Teijlingen et al., 2001). See *Appendix 10.4* for the pilot study.

5.3.4 Main Study

In total, we conducted 30 semi-structured interviews. The main study sample comprises brands, textile manufacturers, textile associations, recyclers, public business institution, NGOs, venture capitalists, embassy, and consulting companies. The interviews lasted 45-120 minutes, with 21 done face-to-face and 9 via Microsoft Teams; all the interviews were conducted in English. To capitalize on the researcher's diversity, we both participated in each interview, which allowed for a more dynamic conversation. Some of the face-to-face interviews, especially with manufacturers, were conducted with more than one participant simultaneously due to time limitations. See *Appendix 10.3* for the interview guide and *Appendix* 10.5 for participants.

Given the great diversity of our sample in terms of actors represented, the standard interview guide underwent some adjustments to suit each interviewee and enhance the pertinence of each discussion. To optimize the opportunity to interview high-profile people, we prepared to be knowledgeable about each participant and organization prior to the interview (Harvey, 2010). Moreover, we sent via email an outline of the nature and the purpose of our research with indications on how the findings would have been helpful for our research and how would have been used (Bell et al., 2022).

The way the interviews have been carried out has been consistent throughout the study. To establish a climate of trust and make the interview feel like a conversation, before diving into the interview guide we engaged in some minutes of small talk (Rubin & Rubin, 2012). Following this, the interview began with the interviewee's presentation and some opening queries about his/her organization. Subsequently, we dived into the sections of the interview guide, and finally, we concluded by asking about potential topics we could have missed during the conversation but that they deemed important. In case such topics arose, we addressed them through follow-up questions. The interviews were recorded and transcribed on the same day, however, for a few interviews conducted during visits to manufacturing facilities, we relied on interview notes as the audio quality was not optimal for transcription, even with the assistance of specific software.

5.4 Data Analysis

After carefully considering the available data analysis methods, the thematic analysis by Braun and

Clarke (2006) was deemed suitable. Following the suggestion of the same authors and Thompson (2022), this method was accompanied by researcher reflexivity, as discussed below in 6.5.1. This method allowed us to identify, subsequently analyze, and report patterns in our empirical data (Bell et al., 2022). A first phase of analysis was conducted parallel to our interview process to get familiar with the data and progressively improve our ability to interview.

After concluding our data collection, we started the coding process. As suggested by Thompson (2022), this process underwent more cycles. A first coding round allowed us to create a link between our empirical data and our cognitive interpretation of them. Then, a second coding cycle led us to consolidate codes with significant overlaps under a single heading. The data was coded individually by both authors and only then compared and synchronized to guarantee quality (Thompson, 2022). As per the thematic analysis, we then developed the themes by analyzing the relationships among the different codes and sorted them based on their ability to jointly unveil the story behind the data. The theory and theoretical framework guided the development of themes, but given our abductive approach, new themes emerged based on our empirical data. This led us to identify and study how different types of collaboration relate to CE adoption, something not evident in the extant literature. Moreover, it allowed us to shed light on how these collaborative dynamics can trigger a self-reinforcing loop that leads circular practices to become an industry norm.

5.5 Quality of the Study

To ensure the quality and trustworthiness of this study, we tried to fulfill three main criteria – credibility, transferability, and dependability - that Guba and Lincoln (1985) define in their approach to the trustworthiness of a qualitative study. Considering our constructivist stance, we decided not to include the confirmability criteria (Stahl & King, 2020).

5.5.1 Credibility

Credibility refers to the degree of congruency of the findings with the reality the researcher aims to shed light on (Bell et al., 2022). To ensure adherence to this criterion, we implemented various techniques, as recommended by Guba and Lincoln (1985). First, we went “native” by submerging ourselves into the literature available in the field throughout the research to become familiar with the recurring instances (Stahl & King, 2020). We analyzed secondary data, discussed with numerous experts, participated in events in Sweden and India, and visited several factories. Therefore, we applied the prolonged engagement method. Second, through persistent observation, in the attempt to

focus and identify the most relevant aspects, we regularly and naturally observed through the participants' point of view. During these observations, we questioned our own assumptions and findings, thus applying the practice of reflexive self-analysis. Third, our study comprises a methodological triangulation (Stahl & King, 2020). Specifically, both researchers took part in every step of the study, and in every interview (investigator triangulation), different data sources were analyzed (data triangulation), multiple theoretical orientations were consulted to understand our findings and direct the research (theoretical triangulation), and actors from different parts of the textile system involved in the study (environmental triangulation). Finally, to further increase the study's credibility, we opted for member validation, to cross-check with them the transcribed material (Bell et al., 2022; Guba & Lincoln, 1985).

5.5.2 Transferability

Transferability refers to the extent the findings are generalizable to other contexts (Guba & Lincoln, 1985). Conducting a case study limits the transferability of the findings to other contexts. Therefore, adhering to Guba and Lincoln (1985) recommendations, we clearly defined the boundaries and limitations of our research and provided a thick description of the phenomenon and the context being studied. By doing so, we allow the readers to make their own judgments about the applicability of our findings to other milieux (Bell et al., 2022).

5.5.3 Dependability

Dependability is concerned with the repeatability of the results of a study (Bell et al., 2022). To achieve this, we tried to guarantee the quality of the acquired materials and thoroughly and systematically documented the research process (Stahl & King, 2020). Furthermore, we adopted the inquiry audit technique (Guba & Lincoln, 1985). Namely, the research process was regularly scrutinized and validated by an experienced external supervisor and fellow researchers, thus ensuring the methods' consistency and accuracy of the interpretations (Stahl & King, 2020).

5.5.4 Ethical Considerations

Throughout the research, we endeavored to conduct it in an ethical manner. The primary consideration was to safeguard the confidentiality of our participants. Therefore, the organizations' and participants' names were concealed. This allowed us to touch upon sensitive and strategic matters during our interviews. Furthermore, each potential participant was presented with the nature and purpose of the research before requesting their willingness to participate. Concerning the interviews,

we asked permission to record and transcribe the conversations and safely store them on our devices.

6 Empirical Findings

6.1 Textile System of Systems

After combining data from primary and secondary sources, our framework appears in Figure 9. The subsystems, *Actors*, *Processes*, and *Values* are now detailed. The *Actors* subsystem comprises the stakeholders directly impacting a textile during its lifecycle and the actors who do not participate in value chain activities but actively influence the textile industry. Generally, fiber, yarn, textile, and garment Manufacturers are classified as Manufacturers. Then, Collectors and sorters are classified as end-of-life (EOL) actors. External actors like NGOs, technology providers, and policymakers are classified as External actors. Therefore, the *Actors* subsystem comprises Manufacturers, Brands, Consumers, EOL actors, Recyclers, and External actors.

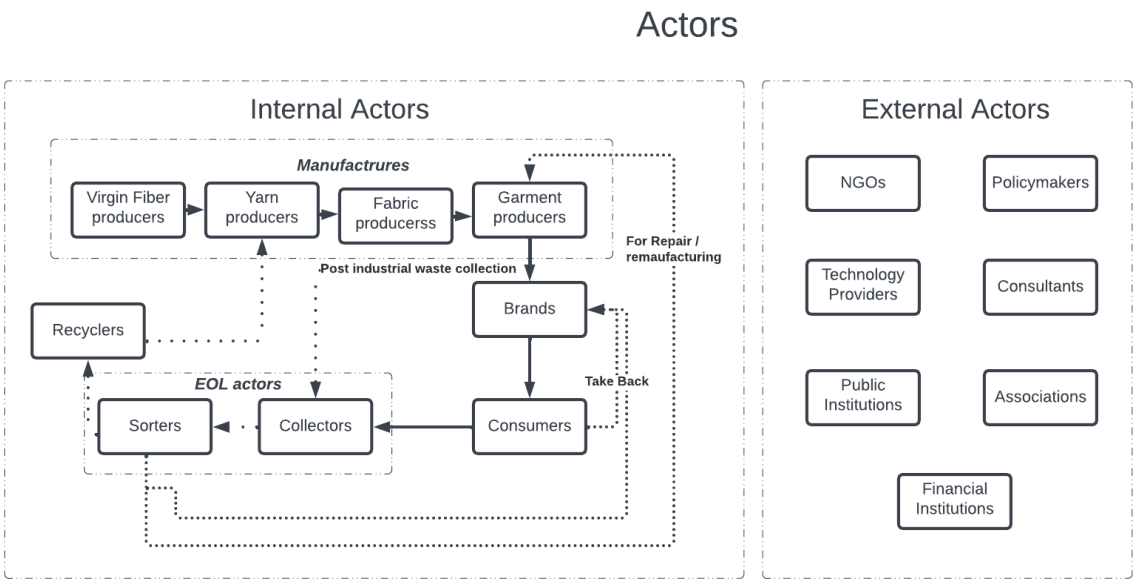

Figure 7: Textile Actors Subsystem

The Processes subsystem comprises the main processes of the textile industry. The production phase comprises virgin and recycled fibers, yarn and fabric, and textile production. The consumption comprises the distribution and use phase. The EOL comprises waste collection and sorting leading to recycling. So, the Processes subsystem comprises production, consumption, and End-of-life (EOL) processes.

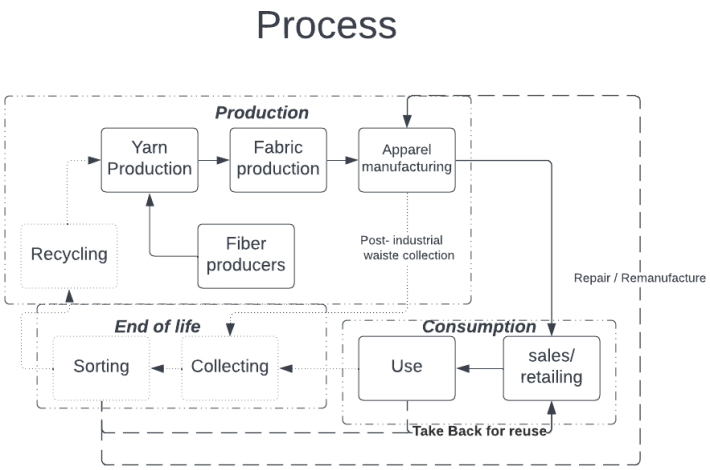

Figure 8: Textile Processes Subsystem

Our findings indicate that the *Processes* subsystem positively and negatively impacts environmental, economic, and social values. No evidence was found for technical values. Therefore, social, economic, and environmental values constitute our *Values* subsystem.

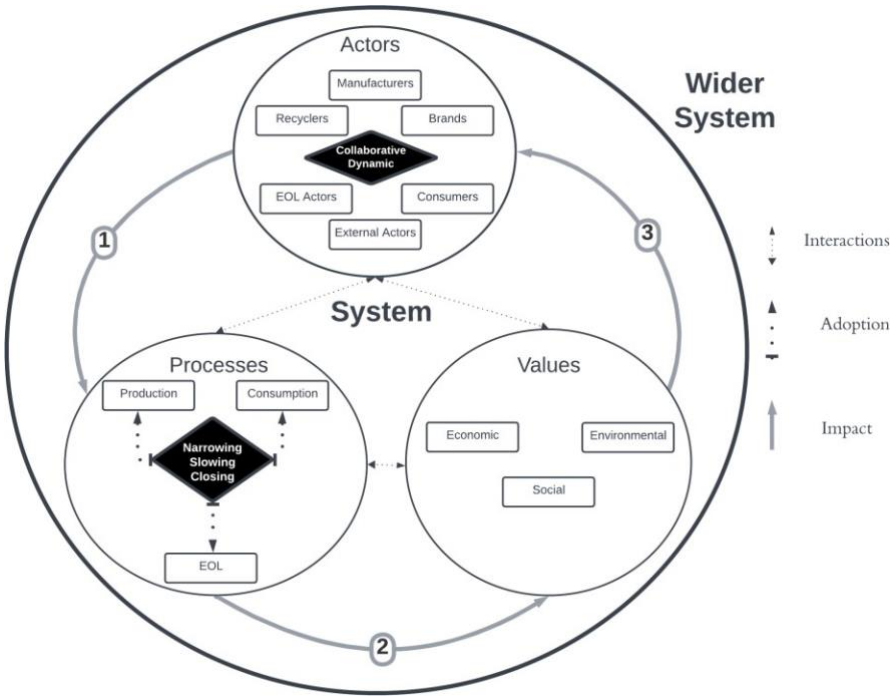

Figure 9: Theoretical framework adapted to the textile industry context

6.2 Crafting Collaboration for CE Adoption

In the following sections, we introduce the types of collaboration identified while investigating CE initiatives in the textile industry. The dimensions of collaboration that emerged are 1) Formalization, 2) Hierarchy, and 3) Centralization. For the theoretical explanation of these different dimensions and associated types of collaboration, please refer to Table 2.

6.2.1 Formalization for CE Adoption

Our findings indicate the existence of both formal and informal collaborative dynamics among internal and external actors.

6.2.1.1 Formal Collaboration

Our findings show that formal collaborations are suitable for comprehensively detailing the common standards and protocols. For example, service-level agreements for delivery are usually written into contracts, with deviations resulting in penalties agreed upon by the actors. Sustainability regulatory compliances and the needed certifications (e.g., SA8000) regarding, for instance, working conditions in manufacturing plants are explicitly specified in the contracts between Brands and Manufacturers. In the transition towards a circular economy, specifications like the percentage of recycled fibers in a garment are delineated as product specifications within the contractual agreements.

Actor 5 – Sourcing Director -B2: "I have worked with international brands, (…) the requirements for compliances have been there written from day one. Brands have their own terms of engagement which need to be met like in terms of social compliance as well as chemical management and wastewater treatment management etc."

Therefore, our findings show that formal collaborations are used to establish the rules of engagement among two or more actors in an explicit, detailed, and written form, including establishing standard operating procedures (SOP) when necessary.

6.2.1.2 Informal Collaboration

Not all interactions can be detailed beforehand, and our investigation demonstrates the presence of many collaborative dynamics aimed at product and process innovation and improvement, which are not governed by written agreements but rather by common interests, values, and tacit agreements.

Usually, actors engage in such collaborations when there is a pre-existing close relationship and a shared positive incentive.

Actor 10, Director-M1: "(…) our recent sustainability projects that we have done after the EU policy came in were guided essentially by brands and we never thought about them before"

Furthermore, informal collaborations also lead to knowledge and best practices sharing activities to, for instance, stay updated regarding the latest market trends, technologies, and upcoming policies. For instance, the Vice President of Operations-Spinning of M5 mentioned how he visited spinning mills in Europe and exchanged best practices about spinning operations. However, many participants reported that these collaborations are restricted to situations that do not lead to the loss of competitive advantage. Actors are careful not to share unique capabilities, which constitute their competitive advantage. They expressed the need for formal agreements to rule out every aspect beforehand for such collaborations.

As our empirical evidence underscores, informal collaborations are used for the dispersion of knowledge and the circulation of best practices within the textile system, resulting in an overall advancement of the industry's standards. Moreover, informal collaborations are employed for product and process innovation and improvement in a context with mutual trust and positive incentives.

6.2.2 Hierarchy for CE Adoption

As discussed in the empirical context, the textile industry is characterized by the hierarchical power of downstream actors, such as Brands. Our findings show that these actors exercise this power in different ways. Another fascinating finding relates to how actors with the same hierarchical power collaborate. The hierarchy factor allows us to distinguish between three main types of collaboration: captive, assessment-based, and relational collaborations.

6.2.2.1 Captive Collaboration

Our investigation demonstrates that downstream actors frequently use captive collaborative arrangements with upstream actors. Low switching costs confer downstream actors the power to dictate the collaboration's modes and goals. Captive collaborations are used mainly when the outcome may not be perceived as economically desirable for the upstream actors, e.g., investments in sustainability.

Actor 9, Sourcing Manager-B4: "every third year we have a questionnaire sending out (…). Here we ask them about important initiatives from a sustainability perspective (…) then we have like a ranking program, so we score the suppliers (…). We do that evaluation one time per year based on different KPIs (….) if they don't manage that, we are not able to proceed with the suppliers."

The same mechanism applies when downstream actors, e.g., Brands, require certifications from upstream actors, e.g., Manufacturers, to ensure the fulfillment of social, environmental, and ethical standards along the upstream value chain. These certifications are a non-negotiable requirement for Brands since they ensure that the products sold on the market comply with sustainable and ethical production standards, whose breach would not only escalate in legal consequences but also seriously damage the Brand's image.

A new instance where Brands are adopting captive collaborations to ensure the adoption of CE practices in the production stages regards the creation of transparency along the value chain. Brands demand visibility into Manufacturers' processes and subsequent value chain to comply with EU regulations and offer Consumers more transparency about the origin of their products.

When hierarchical power is brought into the picture, we observed that upstream actors usually align with downstream actors' demands to show their reliability as partners, considering future business. This assumes particular importance in an industry undergoing a considerable transformation toward sustainability and circularity, such as the textile one.

Actor 15, Marketing Director-M4: "Yes when our customers mention regarding certifications, sustainability and all that stuff, we get it at the earliest possible (…)all this is costly you know but we always try to be a reliable partner to our customers."

Therefore, captive collaboration is used to ensure the realization of initiatives that may not be perceived as economically desirable for the upstream actors, to ensure compliance with regulations, and to create transparency throughout the entire value chain.

6.2.2.2 Relational Collaboration

Relational collaborations arise when actors do not have any dominance over the other parties or, even if they are in such a dominant position, decide not to exercise it. We have observed that these collaborations are present when actors interact to share capabilities with the aim of building long-lasting relationships and fostering trust. For instance, downstream actors adopt a relational style to

help the upstream actors reach the collaboration goals previously set with a captive approach. This facilitates the establishment of trust by signaling to upstream actors the willingness to build a long-term relationship with present efforts that will be rewarded with future business.

Actor 16, Compliance Manager-M5: "brands made visits and explained about the policy and commitment towards sustainability (…), what they want from their suppliers and down the entire supply chain, how we have to integrate with our own supply chain and business partners to grow along with us side by side on this"

Our observations reveal a noteworthy pattern: when concretely rewarded by continuous and expanding business, Manufacturers with longstanding relationships shift from reactive to proactive behavior toward adopting CE practices.

Our investigation has shed light on another situation in which a relational approach is highly present. Namely, actors without any hierarchy in status collaborate to share experiences, knowledge, and capabilities and co-innovate. Brands collaborating to push for a level playing field and Manufacturers collaborating to share expertise and knowledge are a few examples.

Hence, according to our investigation, relational collaborations are utilized when actors interact to share knowledge and capabilities, foster trust, and engage in co-innovation.

6.2.2.3 Assessment Collaboration

The global nature of the textile value chain creates physical and cultural distance between actors. This becomes particularly problematic with the presence of informal channels. The Tier 2 and Tier 3 suppliers are usually SMEs run by families with few employees. These players are usually located in remote villages or peripheral towns and are not knowledgeable or sensitized about sustainable compliances.

During our data collection, we observed that assessment-based collaboration was utilized only in collaborations among upstream value chain actors, particularly with tier 2 and tier 3 actors.

Actor 6, Senior sustainability developer-B3: "For us it's okay to manage with just tier 1, but our supply chain extends beyond (….) tiers 2 and 3 are challenging. It's not very easy to manage and engage with them and that's the challenge in itself."

However, evidence suggests that assessment-based collaboration to manage Tier 2 and Tier 3 actors may not be the optimal choice. This, in turn, has resulted in a lack of transparency in the upstream value chain, especially from Tier 1 and above.

Hence, according to our investigation, we did not find instances where assessment-based collaboration is effective for adopting CE practices.

6.2.3 Centralization for CE Adoption

Coordination centrality is another theme investigated while studying the collaborative interactions among textile system actors. Within this context, collaborative initiatives exhibit varying degrees of centralization, with some characterized by high centrality while others manifest as ad hoc endeavors with comparatively lower centrality.

6.2.3.1 Centralized Collaboration

Centralized collaborations are usually orchestrated by either internal downstream actors or external ones. External actors like NGOs or consultants serve as supporting backbone organizations by setting a common agenda (i.e., set a shared vision for the collaboration, a common understanding of the problem, and a joint approach to solving it) and providing platforms where different actors periodically discuss the barriers, and potential solutions, to the systemic evolution of the system from linearity to circularity. For example, Consultant 1 organizes round tables where Brands, Manufacturers, and technology providers discuss circularity barriers and potential solutions.

Actor 29, Regional Lead-Energy and sustainability consultant-C1: "In Bangladesh, together with the Embassy of X, we have created a platform called Sustainable Fashion Platform and we have partnered with brands like Ikea, Lindex and H&M (…) with the idea of helping Swedish sourcing companies to reduce the overall footprint, improve circularity, and improve resource optimization by helping local suppliers in this transition (…). Our first activity was matchmaking between these companies and technology providers, while brands brought in their major local suppliers. We gave all of them a platform to engage, share information and figure out what kind of collaborations were possible. At the end it led to 70+ meetings and 10+ pilot projects"

Our findings show that NGOs can play a critical role by collaborating with internal actors and acting as knowledge and technology curators. This intervention helps to reduce knowledge gaps and to spread technologies in the entire industry, thus accelerating the adoption of CE practices.

Actor 27, Innovation Associate – NGO 1: "We scout for technologies then our aim is to sort of pilot these technologies together with our partners (…) we do have 22 plus partners now, which includes both the brands as well as the manufacturers (…) we then also support them in scaling these technologies and innovations. We don't just work with the brands or the manufacturers but also with their suppliers if necessary."

Upstream and downstream actors also form associations on their own to discuss common challenges and collaborate to lobby for change at a system level.

Actor 24, Senior member-Textile association 1: "Textile Park is now catching up in India. Keeping the business in the big cities is no more profitable (…) so it's moving into suburbs (...) good thing is the women will get the job right. Because in the villages women are more prominent than male. So we are pushing to the government for textile parks in small clusters in a smaller town (..) initially we need supports to set up the parks, but it becomes viable in long run".

Therefore, centralized collaborations help to create a shared space where different actors with similar interests can regularly communicate, share, and lobby for change based on a common agenda. This can lead to the creation of trust among participating actors, who become more open to collaborating and engaging in increasingly ambitious projects.

6.2.3.2 Decentralized Collaboration

Actors also engage in decentralized collaborative initiatives. For example, the regulation on Manufacturers in India for sustainable disposal of textile waste led to decentralized collaborations with waste collectors and Recyclers.

Actor 1, Director-R1:"we have our manufacturers we talk to, they want to get rid of waste, and we want their waste (…) so it is good for both you know, they make money we make money (…) we ask them to sort by color in their factory already so we only recycle here"

Another scenario is when actors engage in ad-hoc collaboration to share knowledge, capabilities, and technologies, especially when collaborating on technologies and capabilities that could lead to a competitive advantage.

Actor 17, Vice President Operations-Spinning-M5: "(...) research is going on how to use recycled fiber in our spinning operation. (...) There is more R&D going on now in collaboration with big

manufacturers like Rotorcraft. (…) We are going for a trial with them here by putting a machine in the next one or two months to test recycled fiber in our operations."

Hence, decentralized collaborations are employed to share knowledge, capabilities, technologies and co-innovate, especially when potentially resulting in a competitive advantage in the market. Moreover, they are used to initially carry out new needed activities.

6.2.4 Concluding Remarks

In this section of the findings, we have outlined the various types of collaboration utilized by the different actors in the textile system for CE adoption and the reasoning behind their implementation. The table below comprehensively summarizes these collaborative approaches and their objectives.

Table 3:The different types of collaboration

Dimension	Type of collaboration	Key takeaways
Formality	(1) Formal	Establishing clear rules of engagement Establishing standard operating procedure (SOP)
	(2) Informal	Dispersion of knowledge and circulation of best practices Product and process improvement and innovation
Hierarchy	(3) Captive	Realize initiatives when the outcome may not be perceived as desirable for one actor No clear incentive for one actor (e.g., transparency) Enforcing non-negotiable requirements (e.g., regulatory compliances)
	(4) Relational	Share experiences, knowledge, and capabilities Co-innovation Foster trust
	(5) Assessment-based	Did not find evidence where it is successfully employed

Centrality	(6) Centralized	Creation of a common platform for actors with similar interests Establishing common agenda Foster trusts Lobby for change based on a common agenda Share knowledge and capabilities
	(7) Decentralized	Share knowledge, capabilities, and technologies (also those potentially leading to a competitive advantage) Co-innovation

6.3 CE Adoption in Processes Subsystem

The third part of the empirical findings focuses on the *Processes* subsystem. Our empirical data show that optimizing, updating, or transforming existing processes is necessary to drive CE adoption. These circular initiatives can be bucketed into three overarching CE strategies: Narrowing, Slowing, and Closing. The following sections discuss these strategies and the barriers hampering their adoption. For the theoretical explanation of these strategies, please refer to Table 1.

6.3.1 Narrowing

Narrowing refers to all the initiatives that lead to fewer resources consumed per product unit. Both secondary and primary data confirm that the most consumed resources in textile production are fibers (e.g., cotton fibers), water, and energy. Therefore, we will focus on the endeavors aimed at reducing the consumption of these resources.

Reduced fiber consumption is mainly achieved by reducing and reusing the wastage of two main processes: fiber to yarn and fabric to cloth. Regarding the first one, the fiber wastage generated during the spinning process is then properly collected and reused in the processing of the next batch. Regarding fabric to cloth, the waste generated during the cutting process can be reduced through process improvement initiatives like automation and the adoption of digital technology, e.g., CAD systems. Some Manufacturers have successfully transitioned from manual to automated cutting processes, resulting in a noteworthy reduction in cutting and garment rejection waste (i.e., when the cutting is not appropriately made, the garment is rejected).

Actor 20, Associate Vice President Operations-M6: ” (…) we've already squeezed our waste stages in terms of percentage. Currently we are strictly under 1% rejections.”

Reduction in water consumption is achieved by reducing the overall consumption, reusing through recycling, repurposing water after proper treatment, and finally, rainwater capture. Digital printing technology, for example, consumes significantly less water than conventional mechanical printing methods. Another process that consumes a vast amount of water is the dyeing process, through which yarns or fabrics are colored. Using sustainable dyes allows the reuse of dyes and the possibility of treating the processing water, making it reusable. When the fabrics are washed before being transformed into clothes, the water used in the washing process is treated and either reused in the same process or repurposed for other uses, like for washroom systems or gardening. The water used in boilers during the dyeing process is captured as steam and reused for ironing.

Finally, equipment and machinery in manufacturing processes are the primary sources of energy consumption. The two main areas of concern are the type of energy, i.e., green energy or not, and the amount consumed. Updating to new, energy-efficient machines supports the reduction of energy consumption per garment. The switch from Diesel to PNG (i.e., Piped-Natural Gas) as fuel for boilers significantly reduces emissions. Capturing steam generated by the boilers and repurposing it for the ironing process optimizes energy efficiency and helps to reduce the carbon footprint to produce one unit significantly. Manufacturers are now tracking resource consumption using digital technology and optimizing consumption through process optimization and the adoption of new technologies. Green energy helps to influence the carbon footprint by reducing polluting emissions. Solar and wind energy are among the most common forms of green energy.

Actor 21, Managing Director-M7: ”In fact, this particular complex right now we are working to make it into a green complex. This is already (more or less) a green complex in the sense that we use sustainable energy through windmill and now we are adding on solar also so that will become almost 95% green energy. We want to use the sewage and reuse the water so the water can be reused back into gardening or for the toilets”

Predominantly, Brands ahead in the sustainability curve are pushing Narrowing initiatives. Policymakers play a role in expediting the adoption of Narrowing practices. For instance, the NCR (National Capital Region) administration introduced a law, effective October 1st, 2023, to transition

from Diesel to PNG as the primary fuel source. The economic benefit from cost reduction is another driver for adopting Narrowing initiatives.

However, Narrowing practices are still in the adoption phase. Our investigation indicates that the main barriers slowing their adoption are the lack of knowledge among Manufacturers about these practices, the high upfront investments required, which usually are recovered only in the medium-long term, and the lack of a conducive environment in terms of infrastructure and access to green energy.

6.3.2 Slowing

A second strategy essential for the transition from a linear to a circular economy is Slowing. The aim is to extend a garment's life cycle and maximize utilization to slow the resource loop. Our findings show that achieving this objective depends mainly on the garment's design and consumer behavior.

The fibers that make up garments are susceptible to deterioration over time. Hence, it is necessary to design for circularity, which, in the context of the Slowing strategy, means designing long-life products to ensure the garment's physical durability against wear and tear. However, it is also fundamental to design for product-life extension, e.g., ease of maintenance and repair. Hence, with the right design choices and service loops, actors can extend the product life through maintenance, repair, and reuse.

Actor 4, Head of Sustainability-B1: "When it comes to the design itself, we have very high-quality requirements to ensure that the products last (...) once the product is in the hands of the customers, we try to educate them on how to take care of their products (...) We have leather balm, and we have a water-repellent spray for the customer to take care of the product."

The role of design is necessary but not sufficient. Ultimately, the Consumers' behavior plays a crucial role.

Actor 6, Senior sustainability developer-B3: "a t-shirt could be used 60-70 times or even more, now people use it 10-15 times and then buy a new one, this must change if not nothing will change."

Along with Brands, external actors can also play a role in educating Consumers and changing their behaviors. Our investigation shows how NGOs may play a significant role in creating consumer

awareness about the environmental damages caused by an unstainable consumption of clothes and in nudging them toward sustainable consumption patterns.

Actor 27, Innovation Associate-NGO1: "We have a museum in city Y, which basically provides awareness and education to the consumers on sustainable fashion as well about the materials that are being used in the fashion supply chain."

However, our observations also show the presence of several barriers to the adoption of Slowing practices. First, a collective effort from Brands is crucial, given that the initiatives of a few proactive Brands may not be sufficient.

Actor 8, Vice President sustainability-B3: "so when everyone has to do it at the same time, that's so important because if only one company becomes circular, the customers might not understand anything and it might be expensive, counterproductive for the company"

Second, the idea of extending the use phase of garments and eventually reusing them through second-hand channels is generally perceived as a threat in terms of decreased sales volume by Manufacturers. Third, even if policymakers, such as the EU, are providing recommendations on extending garments' life and encouraging reuse, these recommendations still need to be accompanied by proper tangible policies.

Actor 8, Vice President Sustainability-B3: " (...) you know, the tax on second-hand clothes, maybe there shouldn't be VAT on second-hand clothes (...) maybe there shouldn't be VAT on repairing services (...) it would be more smooth if we could have like a policy that really makes it as smooth as possible to put circular products on the market."

While slowing is a critical step for CE adoption in the textile system, the Consumers' attitude toward garments, the lack of economic incentives for Manufacturers to adopt circular design for slowing, the lack of a collective effort, and the lack of tangible policies may prevent its widespread adoption.

6.3.3 Closing

Closing aims to avoid wasting valuable resources in landfills, thus closing the resource loop and reducing the reliance on virgin resources. In the current linear approach, we can distinguish between two main categories of waste: post-industrial textile waste and post-consumer textile waste. The first category of waste is generated during manufacturing, particularly during the cutting process when

fabrics are transformed into clothes. The second category of waste pertains to the products Consumers discard at the end of their useful lifespan, per the consumer's assessment. Post-industrial cutting waste is considered superior to post-consumer waste since it does not endure the wear and tear of the use phase.

Our empirical findings show that closing the loop is challenging since it requires the coordination of multiple actors to design for circularity, create traceability in the value chain, orchestrate reverse logistics, establish sorting and recycling capabilities, and so forth.

As far as recycling is concerned, mechanical recycling is the most used technique. However, mechanically recycled fibers have quality and design restrictions, which demand modifications/adjustments to existing processes. Even though new techniques promising recycled fibers as qualitative as virgin ones, like textile chemical recycling, are emerging, the higher costs and the risks associated with a new technology create viability issues.

Actor 17, Vice President Operations-Spinning M5: "Currently our machines are calibrated for virgin cotton. It will not work for recycled fiber due to low length (…) so you need a different machine all together or you need at least some modifications and some accessories to existing ones."

For post-consumer waste, reverse logistics usually starts with collecting used garments, followed by sorting, with recycling that happens only after proper sorting. The Recyclers have reported the lack of availability of qualitative feedstock as a major issue. Our findings indicate the presence of informalized channels and processes as a major barrier. These challenges have led to most of the textile waste being downcycled, e.g., fiber content for car seats and sofa stuffing, home insulation, and so forth, or ending up in landfills.

Actor 3, Vice President Supply Chain & Sourcing-R3: "We have the capacity, but we need a good well sorted feedstock, and we need predictability (…) we need to exactly know the quantity of feedstock we can receive every month so we can plan capacity (…)so quality and predictability are not there".

There are similar challenges for post-industrial textile waste, but there is evidence of progressive formalization. Few Manufacturers have started recognizing post-industrial waste as a resource and

reverse logistics as part of their value chain. Therefore, they are trying to find formal collectors and Recyclers and stipulate agreements to handle post-industrial waste adequately.

While Closing practices are critical for the CE transformation of the textile system, a few obstacles must be surmounted for its widespread adoption. The lower quality of mechanically recycled fiber, coupled with the nascent stage of the textile chemical recycling technique and a low level of formalization in the collection and sorting processes, pose significant challenges to closing strategy adoption.

6.3.4 Concluding Remarks

In this section of the findings, we have outlined the various types of CE strategies, their related practices, and the barriers to their adoption. Table 4 displays an overview of the barriers related to each strategy.

Table 4: The identified barriers to the CE strategies

Strategy	Barriers
Narrowing	Lack of knowledge about Narrowing practices
	High upfront investments with ROI over the medium-long term
	Lack of a conducive environment
Slowing	Consumers' attitude
	Lack of economic incentives for circular design for manufacturers
	Lack of collective effort for a sustainable fashion cycle
	Lack of requisite policy frameworks
Closing	Lower quality of mechanically recycled fibers
	Nascent stage of the textile chemical recycling technique
	Low level of formalization in the collection and sorting processes

6.4 Influence of Values on Actors

The last part of our empirical findings concerns the *Values* subsystem, which refers to both the positive and negative impacts of adopting circular strategies in the *Processes* subsystem. Understanding the importance of these outcomes provides critical insights into the cause-and-effect

relationships among the different subsystems and reflects the potential to drive change. The major values identified during our investigation were Economic, Social, and Environmental, i.e., the triple bottom line. The triple bottom line concept is essential for Brands, especially for European ones, since most of their sales are realized in developed economies, such as the European countries, where regulators are driving a green transition, and Consumers are shifting their preferences towards sustainable products (Rausch et al., 2021).

Actor 8, Vice President Sustainability-B3: "But now, with the EPR coming, everyone will be forced into circular economy (…) there will be a tough time for those that cannot offer sustainable products"

6.4.1 Economic

Offering sustainable products will no longer be a differentiation strategy but a prerequisite for a Brand's survival. However, the economic bottom line is the primary value impacting the system actors. The complexity of the textile industry also lies in the fact that the manufacturing countries, except China, are all developing or undeveloped economies, and the priority of needs is different compared to the countries where most of the consumption happens. The main concern of policymakers in countries like India is taking and keeping people out of the poverty threshold. Investments in circularity are costly and may not yield any economic benefits in the short term, if not at all. Therefore, many Manufacturers only invest in compliance or sustainable certifications predominantly based on their business impact. Still, they may be reluctant toward proactive circular investments due to the lack of short-term benefits and clarity on the long-term benefits of such up-front investments.

Actor 11, HR, Compliance and Sustainability Manager-M1: "In the end the business of business is business (…) most people over here are really not interested (in circularity investments) because for them to fulfill their basic need (sustaining business) is the most important thing, they cannot take much risk?"

At the same time, few manufacturers proactively invest in circular initiatives. Our data shows this is mainly due to long-lasting relationships with Brands ahead in the sustainability curve. The trust and alignment created among these actors are perceived as indirect promises of future business.

Actor 10, Director-M1: "They (investments) happen mostly on the trust factor and all. I don't know when I will be able to recover the cost of the solar plants which we have implemented, but I'm sure that with brands X and Y is not short-term."

The discourse concerning the economic bottom line cannot be approached as a simplistic matter of increased or decreased profits for proprietors. Instead, it must be contextualized within the economic and social fabric of the country. Without this level of complexity in the analysis, achieving a transition towards a CE will prove challenging since this transformation necessitates the engagement of numerous interdependent actors, each with different needs and priorities.

6.4.2 Social

The textile industry has been notorious for its problems related to social sustainability. After tragedies like the Rana Plaza incident in Bangladesh, the entire industry has started to be strictly scrutinized by policymakers, public opinion, and NGOs. The social bottom line, especially concerning the work conditions in manufacturing countries, is a high-stake outcome for Brands as any breach of ethical standards can heavily damage their reputation. During our interview, several Manufacturers proudly displayed and explained to us their certifications and during our visits showed us all the facilities and amenities they built for the employees, e.g., comfortable canteen, ventilation systems, etc. Social compliance certifications play a significant role in ensuring the adherence to ethical standards in the upstream value chain.

The initiatives that positively impact Environmental values do not always positively impact social values. For instance, there has been a call for automated sorting processes to enhance the quality of feedstock, thereby improving the efficiency of the recycling process. In developing economies, this is an area where many people are employed. While automation can improve sorting outcomes, thus enhancing the subsequent recycling phase, it can also lead to unemployment. In the same way, an increase in the use of recycled fibers may impact the cotton industry and its livelihood.

Furthermore, the Slowing strategy may reduce the sales volumes for Manufacturers, thus reducing their revenues. Adverse effects on the top and bottom lines of sales can impact the salaries and benefits each actor can provide their employees.

Actor 11 HR, Compliance and Sustainability Manager-M1: "sustainability, circular economy all can be explained and it is very easy for them who are sitting over there (…) It is very much

important to understand us. We have 1500 workforce, so approximately feeding 6000 people per month, you know? In entire India the textile industry is the second highest employment generator after the agriculture industry you understand?"

As previously discussed, promoting transparency throughout the entire value chain is crucial to monitoring the integration of CE strategies during production. Moreover, External actors and Brands highlighted the importance of transparency also to monitor the working conditions in the value chain.

The transition of the textile system towards a CE involves initiatives that have the potential for both positive and negative social outcomes. A successful initiative must yield positive environmental and economic outcomes but at least avoid negative social impacts. It is essential to balance all three aspects to ensure the initiative is sustainable and impactful.

6.4.3 Environmental

As discussed in the empirical context, the textile industry's environmental impact is abnormal. Policymakers, academia, NGOs, and environmentally sound Consumers are demanding a shift away from a "take-consume-dispose" culture and embrace circularity. The Brands ahead in the circularity curve have proactively addressed the issue and advocated for change; however, as stated by Actor 8 in (6.3.2), the absence of a collective effort could make the efforts of the most proactive Brands ineffective.

Our findings indicate that economic incentives predominantly drive Manufacturers. However, few Manufacturers have proactively adopted initiatives with economic and environmental benefits, even without short-term benefits, as they see long-term value.

Actor 11, HR, Compliance and Sustainability Manager-M1: "We have converted 400 machines from clutch motor to direct which consumes only 18% to 20% electricity in eight hours. So here again we are saving the electricity. The benefit is coming to us and we will be recovered in few years."

The Manufacturers that are still driven by a short-term mindset instead are focused only on those initiatives that lead to short-term economic benefit; for instance, sourcing cotton adhering to BCI standards requires an additional effort but pays off immediately since the Brands are willing to pay more for it.

The market demand for circular products can have a ripple effect within the system. The demand for sustainable garments has led to innovations up the value chain, where the Manufacturers working with sustainability-oriented Brands have made the production processes and the product itself more sustainable. At the same time, this has pushed Brands like H&M to develop new circular business models and pushed innovators like Renewcell to innovate recycling technologies to improve the quality of recycled products. However, the major push for circularity is from policymakers, such as the EU, as testified by the upcoming policies and the already numerous recommendations and regulations on CE principles (European Commission, 2008, 2022).

6.4.4 Concluding Remarks

In this section of the findings, we have presented how different actors may distinctly perceive the same values based on their sometimes conflicting interests and necessities. Additionally, we have outlined how these divergent perceptions of values may impact their decisions. Table 5 displays the main points discussed.

Table 5: The three dimensions of Values subsystem

Dimension	Key takeaways
Economic	Lack of short-term economic incentives demotivates actors, especially in manufacturing countries Actors with long-lasting relationships with sustainable Brands develop long-term mindsets and may be willing to sacrifice short-term economic benefits for long-term business sustainability and growth
Social	High-stake outcome for downstream actors like Brands Adoption of certain CE practices may have adverse consequences on social sustainability Policymakers, NGOs, and Brands drive the emphasis on social values
Environmental	Environmental initiatives with short-term economic benefits are readily incorporated Environmental initiatives with long-term economic benefits are incorporated by proactive Manufacturers with a long-term mindset Policymakers, NGOs, and most proactive Brands drive the emphasis on environmental values and CE

7 Discussion

In this section, we discuss our findings from the perspective of our theoretical framework by addressing our research question. First, (7.1) we discuss how the various types of collaborations identified in (6.2) may drive the adoption of CE strategies by helping to overcome the ir related barriers. Second, (7.2) we introduce and discuss the concept of "circular lock-in".

7.1 How Collaboration helps to overcome CE barriers

In this section, discourse will concentrate on answering our research question by discussing the impact of collaborative dynamics on CE adoption, the gray arrow (1) in Figure 9, now represented in a more detailed way in Figure 10. We discuss how collaboration invoked in the context of CE adoption helps overcome obstacles to Narrowing, Slowing, or Closing identified in (6.3) and summarized in Table 4.

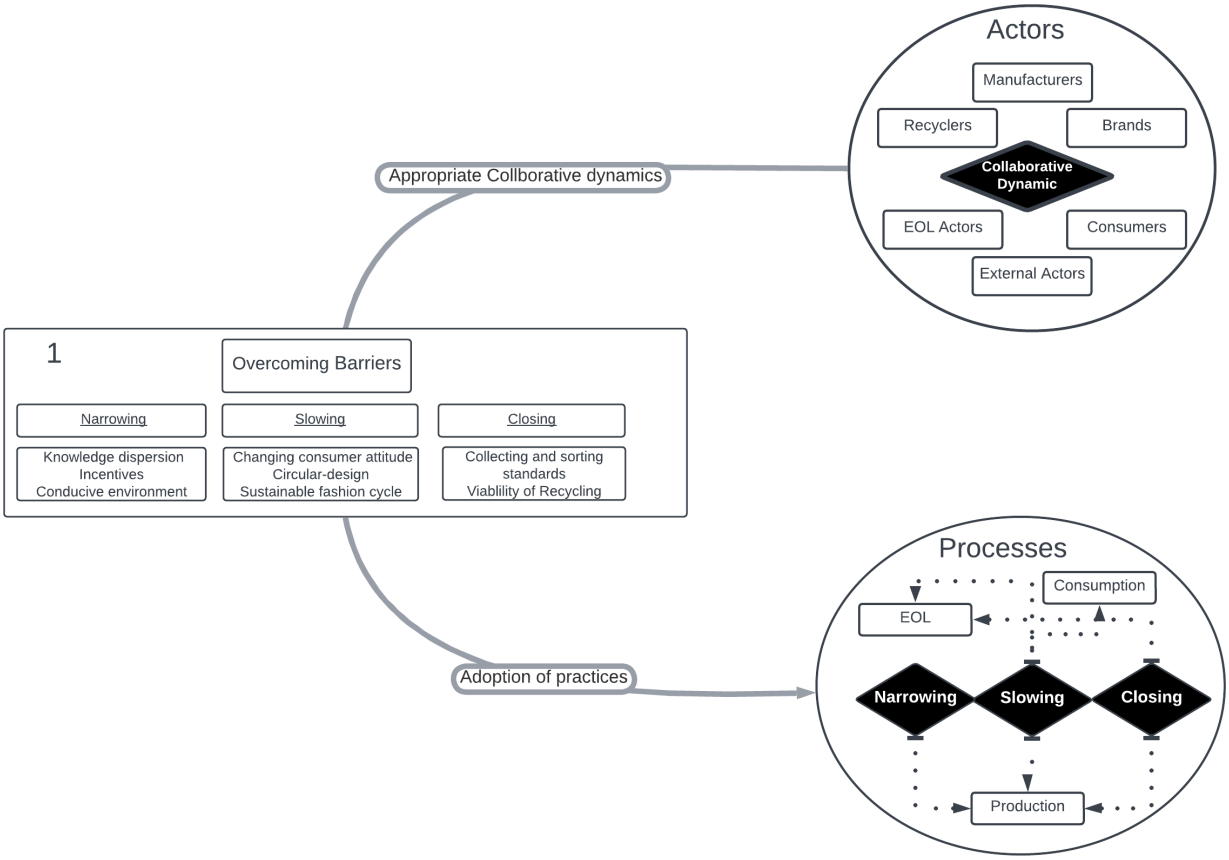

Figure 10: Collaboration to overcome CE barriers

7.1.1 Driving Adoption of Narrowing Strategies

The barriers to Narrowing identified in the empirical findings section must be addressed to drive CE adoption. The barriers identified are 1) knowledge-related barriers 2) Incentive-related barriers 3) lack of a conducive environment.

Table 6: Driving adoption of Narrowing strategies

Barriers	Key takeaways
Overcoming knowledge-related barriers	**Centralized collaboration** Creates common platforms to discuss problems and develop solutions Triggers sharing of knowledge and best practices Creates visibility on trends and upcoming policies **Decentralised collaboration** Knowledge and best practices sharing among individual actors
Overcoming incentive related barriers	**Combination of Captive and Relational collaboration** Realized initiatives whose outcome is not perceived as favourable by the non-dominant actors Foster long-term collaboration and perspective
Creating a conducive environment	**Centralized collaborations** Lobbying for change Orchestrating a conducive environment

7.1.1.1 Overcoming Knowledge-related Barriers

The lack of knowledge about the concept of CE and, consequently, about the best practices to narrow down consumption of resources act as a major barrier. Our findings align with Ki et al. (2020), who reported that knowledge dispersion among stakeholders is a fundamental step toward the circular transition. Here, we expand their work by explaining how collaboration can be a means to operationalize what the authors call knowledge support.

Centralized collaboration can play a major role in overcoming the knowledge gap. External actors from civil society, such as NGOs, but also from the private sector, such as consulting companies, act as backbone organizations. They create common platforms to bring various actors (e.g., Brands, Manufacturers, Innovators, and so forth) together to periodically discuss problems and innovate solutions related to CE in the textile industry. These common spaces facilitate interactions and collaborations among actors, and the periodicity of these meetings helps in trust-building. The backbone organization sets a common agenda based on values and goals that every present actor shares. Trust, in turn, triggers knowledge-sharing and best practices-sharing activities among these actors. These knowledge-sharing activities are carried out informally based on common values and interests, for example, making the industry more sustainable. Actors not only acquire new knowledge but also shape an identity reflective of a commitment to sustainability values. Furthermore, centralized collaborations facilitate the curation of best practices, market trends, and upcoming policies, giving the value chain actors the ability and motivation to adopt circular practices. The knowledge arising from these meetings can then be curated, aggregated, and published in industry reports for further knowledge dispersion.

Decentralized collaborations can also contribute to overcoming the knowledge barrier through ad-hoc collaborations among different actors. This can involve downstream actors sharing their knowledge about best practices and upcoming policies with upstream actors with the common interest of improving each other's business. For instance, Brands share best practices for water conservation with their Manufacturers in order to reduce the amount of water utilized in the production of goods, such as a T-shirt, that will ultimately be sold to Consumers. Ad-hoc decentralized collaborations also emerge between different actors operating within the same level of the value chain and between internal and external actors. This includes, but is not limited to, collaborations between Manufacturers and other Manufacturers, and between Manufacturers and NGOs.

7.1.1.2 Overcoming Incentive-related Barriers

While bridging the knowledge gap about Narrowing practices is the initial step, it must be backed by a willingness to invest in adopting them. During our interview, it emerged that upstream actors are reluctant to invest without short-term ROI. The upstream actors usually prefer to "wait and watch" till the practice becomes the norm. This inversely affects the rate of CE adoption and demands intervention from other actors.

Our empirics indicate that captive collaboration is effective in situations where the initiative's outcome is not perceived as favorable by the non-dominant actors in a hierarchical setup. Captive collaboration can also be deployed to shift the perspective of upstream actors, such as Manufacturers, from a short-term to a long-term perspective. Pedersen et al. (2019), through a case study on introducing a new t-shirt concept by a fashion Brand, argue that a shift from a short-term to a long-term mindset is required to adopt CE successfully. The findings of our investigation confirm these authors' argument and shed further light on a possible means to achieve such a shift in mindset. We observed that the change of perspective is obtained by dominant actors employing captive collaboration with non-dominant actors to make them understand that to have a long-term business relationship, they must align with the vision and progressively adopt CE practices.

However, there is also a need to align upstream actors to the vision of downstream actors by clearly explaining the reasons behind the vision, such as the shifting Consumers' preferences and the future upcoming policies. Subsequently, to concretely achieve the vision and the goals set, a relational approach to collaboration without any dominance helps to build a long-term relationship in which, through frequent interactions, the downstream and the upstream actors work together to create more circular processes and products. Hence, relational collaboration helps align the objectives and vision of upstream and downstream actors, leading to the practical realization of the same.

A particularly interesting finding is that the long-term relationship brought about by a more relational collaboration can lead to switching the behavior of upstream actors from reactive to proactive. For example, Manufacturers that have worked for a long time with Brands ahead of the circularity discourse are now proactively investing and exceeding Brands' expectations, which do not need to use their hierarchical power towards these suppliers anymore. Our investigation confirms Pedersen et al. (2019) suggestion that a shift from a short-term to a long-term mindset is required to implement CE successfully and it aligns with Golini and Gualandris, (2018), who argue that relational collaboration can obtain upgrading effects with suppliers.

So, it is important to employ a captive collaboration to demand investments with a long-term outlook and closely monitor and evaluate if the upstream actors are investing in the necessary improvements.

This aligns with the findings of Pagell et al. (2010) recommend captive collaboration for issues with high strategic importance. Furthermore, a Relational collaboration can foster trust and create

alignment, leading to proactive investments and collaborative innovations. Hence, overcoming incentive-related barriers to narrowing calls for a combination of relational and captive approaches.

7.1.1.3 Creating a Conducive Environment

The availability of green energy is critical to narrowing efforts as the type of energy used determines the carbon footprint per unit. While bigger upstream players have the financial resources to invest in solar and wind energy, it may not be possible for small and medium-sized Manufacturers.

Our findings show how smaller players engage in centralized collaborations, e.g., textile associations, in order to create power dynamics and subsequently lobby for change towards the public institutions to obtain help in terms of economic subsidies for building solar energy, wind energy parks, and textile parks. These centralized collaborations are also employed to lobby academia and innovators to develop technologies to address their needs to become more circular, as showed by the case of the Textile Association 1 and its relationship with the local technical universities, as well as their current effort to obtain subsidies from the Indian government to build a textile park where they could share facilities such as solar panels, wind turbines, water recovery plants and so forth.

Centralized collaborations are also employed to pool resources for problem-solving and innovation. As in the case of the Sustainable Fashion Platform created by Consultant 1 and the Swedish Embassy in Dhaka, the centralized collaboration provided a platform to gather various actors, such as Brands, Manufacturers, Innovators, Technology providers, and Academia. In such a context, actors can identify common problems and work together toward a solution. The initiative from Consultant 1 created an environment for innovation and resulted in more than 70 pilot studies, making the Manufacturers of Swedish Brands in Bangladesh more circular.

7.1.2 Driving Adoption of Slowing Strategies

The second strategy in CE involves prolonging the use phase of a product. This can be accomplished through Consumers using the product for longer periods (use-hours) followed by product undergoing a reuse phase, and potential repair if necessary. This approach necessitates three key prerequisites: 1) a shift in consumer attitudes, 2) a sustainable fashion cycle, and 3) products designed following CE principles.

Table 7: Driving adoption of Slowing strategies

Barriers	Collaborative dynamics
Change in consumers' attitude	**Centralized collaboration** More impactful awareness and education campaigns Coordination of single actors' campaigns **Decentralized collaboration** Create awareness and educate Brand-specific customers Support customers by providing maintenance and repair services
Circular Product design and manufacturing	**Combination of Captive and Relational collaboration** Captive collaboration creates alignment even when the outcome may not be perceived as desirable, and relational collaboration develops trust, fostering co-innovation
Sustainable fashion cycle	**Centralized collaboration** Create a level playing field Create a platform to unify efforts Create power dynamics to lobby for change and conducive policies

7.1.2.1 Changing Consumers' Attitude

Most of the participants in our study consider the customers to be critical actors in the transition from a linear to a circular economy. However, the prevalence of fast fashion has resulted in a linear lock-in with Consumers who have become accustomed to frequent fashion cycles. To transform their attitudes towards consumption, raising awareness about the negative consequences of unregulated consumption, educating individuals about the significance of extending the lifespan of their garments, and normalizing second-hand shopping, is essential.

Our findings show the presence of individual efforts from the most sustainable Brands in their communication campaigns. In some cases, Brands, e.g., Sandqvist, accompany these communication efforts with concrete services to prolong the lifespan of their products. Along with these decentralized collaborations between single actors and their customers, our findings indicate the presence of collective efforts.

Centralized collaborations among various actors can make these educational campaigns more resonant by speaking to Consumers through a common and coherent voice. In such an effort, external

actors from civil society, such as NGOs, act as aggregators of internal actors, e.g., Brands, by offering a common voice through which collectively change Consumers' attitudes towards garment consumption. Per the participants' reflections, having a central backbone organization like an NGO is essential to prevent fragmented and incoherent communication that could lead to confusion and misunderstanding among Consumers. Such centralized collaborations help design joint communication campaigns and coordinate each actor's independently conducted campaigns. This has led NGO 1, in collaboration with its partners, to open a textile museum to sensibilize the public about the current unsustainability of the fashion industry. As mentioned earlier, such common spaces also aid matchmaking activities, leading to ad-hoc decentralized collaborations among Actors based on shared interests, as in the case of the innovator Vaayu collaborating with Vinted to create the largest-ever primary dataset on the climate impact of shopping second-hand online and at scale in the attempt to raise awareness on the importance of this new way of shopping.

In line with Ki et al. (2020), we highlight the importance of awareness and education campaigns to make consumers not only support but also choose circular products; on top of their findings, we further suggest how centralized collaborations may be an effective means to achieve this objective.

7.1.2.2 Circular Product Design and Manufacturing

Change in consumers' attitudes without long-lasting textiles is futile. Products must be designed to be used for a longer period of time and eventually reused. The product design for longevity demands collaboration among internal actors, particularly Brands and Manufacturers. Similar to the discussion in (7.1.1.2), a mix of captive and relational approaches to collaboration appears to be fundamental in making the Manufacturers share the Brand's vision of producing long-lasting garments. Our findings show that if such alignment is achieved, Brands and Manufacturers can start co-innovating new circular designs based on longevity and repairability, ultimately slowing the loop. Moreover, Manufacturers need to adapt their processes and acquire new skills to produce garments based on these new circular designs. Additionally, the level of captive and relational collaboration employed should be greater than that discussed in (7.1.1.2) since slowing can be perceived as a threat by upstream actors as it directly impacts the manufacturing volume.

As in the case of the investments for adopting Narrowing practices, the Manufacturers, which have been collaborating relationally with sustainable Brands for a long time, have become proactive and,

in some cases, have developed internal design capabilities, thus proposing innovative circular designs to Brands before they demand them.

7.1.2.3 Sustainable Fashion Cycle

Research findings indicate that the phenomenon of garments being discarded is significantly associated with their falling out of fashion (Nayak, 2019). While creating durable apparel and changing consumers' attitudes are pivotal, an extended fashion cycle must also be integrated in order to complement these efforts coherently. Brands need to make conscious efforts to minimize the frequency of fashion iterations. A longer fashion cycle can create the possibility of garments being used for longer periods without going “out of fashion”, thus enhancing possibilities for reuse through second-hand shopping.

However, decentralized efforts by sustainable Brands may have negative repercussions, such as unsustainable Brands poaching the customer base. Centralized collaborative dynamics can provide a platform for Brands to unify their efforts to change fashion trends based on a shared agenda. As our findings show, centralized collaborations would also create the needed power dynamics to lobby for policy changes, thus creating momentum for the transition toward circularity. Indeed, as mentioned by the majority of the participants, to create a sustainable fashion cycle based on CE principles, actions by internal actors must be enhanced by external actors. Regulators have a crucial role in designing policies, e.g., VAT discounts on second-hand garments, that would further incentivize slowing efforts from internal actors.

7.1.3 Driving Adoption of Closing Strategies

In order to ensure that valuable resources are not wasted and to mitigate environmental impact, it is necessary to collect post-industrial and post-consumer textile waste, followed by proper sorting and recycling to create fibers that can then be reintroduced into the production process. Ideally, garments made from recycled fibers should possess the same quality as those made from virgin fibers. However, recycled fibers are currently not a perfect substitute for virgin fibers, and a few significant challenges hinder the adoption of the Closing strategy. These challenges include hurdles in collecting and sorting textile waste, as well as the viability of recycling processes.

Table 8: Driving adoption of Closing strategies

Barriers	Collaborative dynamics
Standards for collecting and sorting	**Formal collaborations** Establish standards and formal processes
Viability of Recycling	**Relational collaboration** Support innovation to improve quality
	Decentralized collaboration Innovation leading to competitive advantage
	Centralized collaboration Creating awareness in the market to drive adoption. Matchmaking activities for innovation

7.1.3.1 Standards for Collecting and Sorting

At the conclusion of a product's life cycle, gathering the garments and segregating them into three categories based on their suitability for further use is essential. The first category comprises garments that are fit for direct reuse. The second category includes garments that require repair before being put to reuse. The third category consists of garments unsuitable for reuse due to their poor conditions, which need to be recycled. This step is fundamental to closing the loop, thus preventing precious resources from ending up in landfills.

Our empirical findings show that the lack of clearly defined standards and procedures in post-consumer waste collection and sorting processes adversely impacts the recycling process and, consequently, the ability to close the loop. This contrasts with Ki et al. (2020), who consider the only major barrier to sorting and collecting to be of a technological nature; we argue that another significant barrier regards the absence of formal collaborations among internal actors. According to our findings, the absence of established standards leads to suboptimal execution of collection and sorting processes, which poses a significant supply chain risk for recycling companies regarding feedstock availability and quality. This, in turn, makes it difficult for these companies to plan their capacity effectively, resulting in an inability to guarantee Manufacturers and Brands a specific quantity of recycled fibers. As a result, Manufacturers and Brands may be reluctant to expand their

use of recycled fibers due to unpredictability in procurement. According to our findings, lack of standards is one of the causes of post-consumer waste still ending up in landfills.

Therefore, to effectively close the loop, our empirics suggest that post-consumer waste collection and sorting processes need to be governed by formal collaborations, where the responsibilities, activities, and incentives are clearly defined for each involved actor. This formalization of processes is important in a system where one actor takes ownership and organizes the take-back system, e.g., the H&M take-back program. It becomes even more critical in a system where collection and sorting are carried out by multiple actors, e.g., charities, single retailers, and so forth.

Regarding post-industrial waste, informal collaborations have the same detrimental effects as for post-consumer waste. Indeed, informal collaborations are suited when the relevant actors have common interests or shared outcomes. Our findings point out the presence of divergent interests. Manufacturers prefer to avoid sorting the waste in-house and prefer a high pick-up frequency, while Recyclers prefer sporadic bulk pick-up of sorted waste.

Our study shows that Formal collaborations based on written contracts and established standards result in Recyclers getting pre-sorted high-quality textile feedstock with better predictability. At the same time, Manufacturers gain better value for sorted waste. Finally, we have also observed situations in which a third actor, the collector, mediates between Manufacturers and Recyclers and processes sorting. Also in this scenario, participants indicate the need to establish the value chain formally. Brockhaus et al. (2014) argue that formal collaboration can be used to establish standards; in the second stage, the collaboration should be more relational. However, we argue that formal collaboration should not be replaced by relational collaboration but rather complimented by a relational approach for process innovation.

7.1.3.2 Viability of Recycling

For recycling to become the norm in the textile industry, it has to be economically viable. Ultimately, economic viability depends on the final demand for recycled fibers.

Mechanically recycled fibers are of lower quality as they are shorter than virgin ones. To drive mechanical recycling, Manufacturers must collaborate with technology providers to improve the quality of garments made from recycled fibers. Moreover, Brands must collaborate with Manufacturers to design products using recycled fibers. While Relational collaboration can drive

design innovation between Manufacturers and Brands, Decentralized collaboration is employed between Manufacturers and Technology providers as Manufacturers see this as an opportunity to develop a competitive advantage.

Recently, another chemical recycling technique is promising recycled fibers as qualitative as virgin ones, i.e., they have the same length as virgin fibers. However, chemical recycling is relatively new and expensive compared to mechanical recycling and has yet to gain popularity and widespread adoption among Brands. Our findings show how centralized collaborations based on a common backbone organization, like Fashion For Good, have helped create market awareness about these new recycled fibers and facilitated matchmaking activities between innovators, Manufacturers, and Brands. Mass-scale adoption of chemically recycled fiber will create the necessary economies of scale, thus making chemical recycling more viable and fostering further innovation. For instance, Renewcell has already commercialized over 250+ styles made with CIRCULOSE® in collaboration with Brands like Inditex, H&M, Levi Strauss & Co., and PVH Corp.

7.1.4 Concluding Remarks

In the first part of our discussion, we analyzed how different types of collaboration can be orchestrated to overcome the barriers to Narrowing, Slowing and Closing identified in (6.3) and drive their adoption. In the next part of our discussion, we will introduce the concept of "circular lock-in" to shed light on the systemic effect of collaboration for CE adoption.

7.2 Circular lock-in

In this section, we discuss the second part of our investigation concerning the impact of the adoption of CE strategies on the *Values* subsystem (2) and, subsequently, the impact of the *Values* subsystem on the *Actors* subsystem (3). To comprehensively address our research inquiry and avoid potential oversights in adopting CE, using our comprehensive theoretical framework, we introduce a concept called "circular lock-in" represented through Figure 11.

To articulate this concept, we must focus on the *Values* subsystem. Our research reveals discernible disparities in perspectives on Values among various actors, particularly in regions with distinct cultural, social, and economic structures. This divergence adds complexity to the investigation of the impact of Collaboration on CE adoption, emphasizing the need for a holistic approach to ensure a thorough exploration of all the pertinent facets.

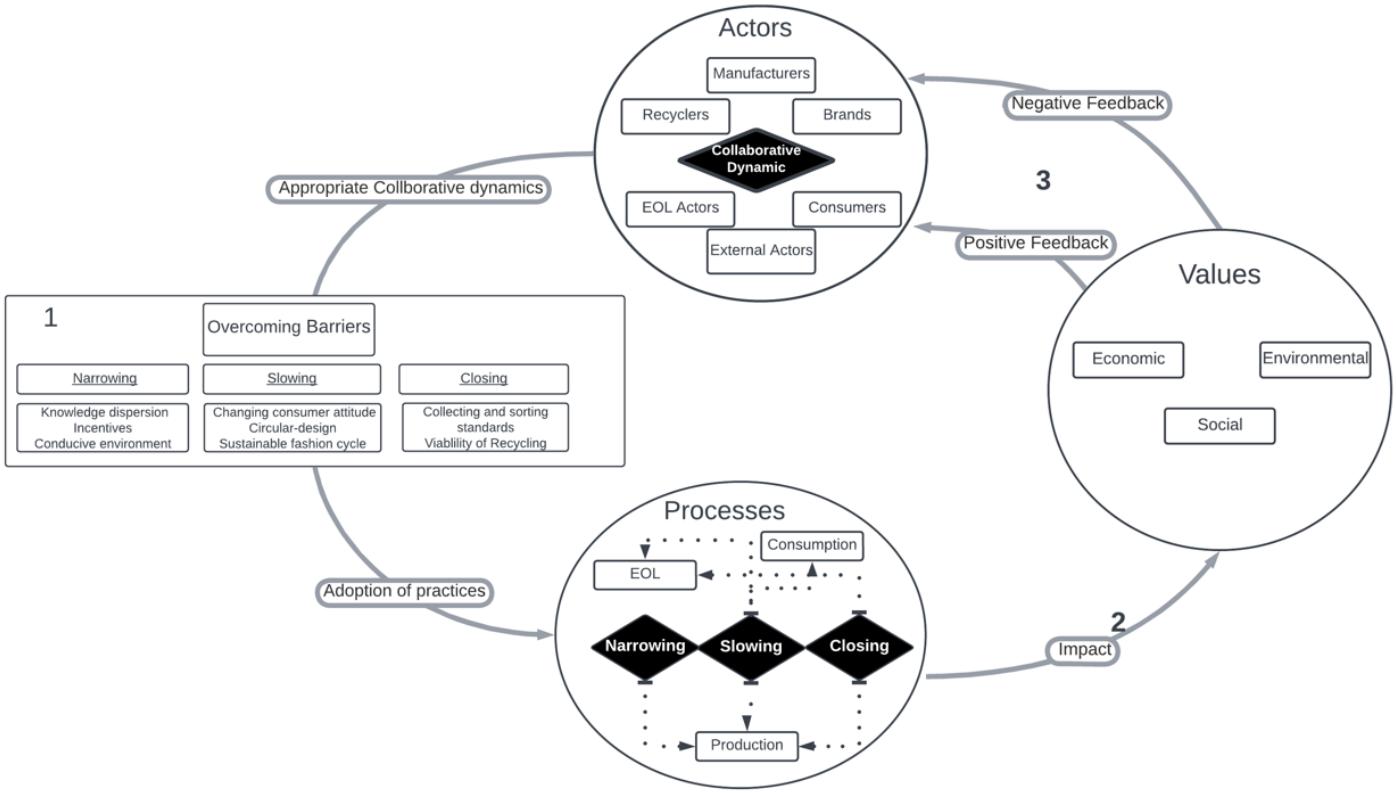

Figure 11: Collaboration for CE adoption and its systemic impact

Our framework elucidates the influence exerted by collaborative dynamics within the *Actors* subsystem. This influence extends to adopting CE strategies and associated practices within the *Processes* subsystem, where the loop can be tangibly closed, subsequently influencing the *Values* subsystem. Ultimately, outcomes within the *Values* subsystem will determine the initiation of a positive self-reinforcing loop, culminating in realizing the circular lock-in or a negative feedback loop leading to systemic resistance.

However, evaluating this cause-effect chain within the system demands transparency across the value chain. Transparency is critical to a) understand the context where collaboration is orchestrated, b), assess the level of adoption of CE practices, and c) the impact of the adoption on the *Values*

subsystem. Transparency can be brought about by practices like open book costing, which can shed light on the impact on Economic and Social values, and traceability initiatives like digital product passports (DPP), which are digital representations of physical products that show sustainability data throughout the product lifecycle.

Our empirical findings indicate that strategic collaborations among actors, tailored to overcome specific barriers, can lead to the gradual assimilation of practices aligned with CE strategies, which, in turn, may have an impact on Economic, Environmental, and Social values. We underscore the assumption of a positive environmental impact given the inherent purpose of these CE strategies.

A thorough assessment entails considering both the economic and social aspects of value. When relevant actors can create economic and social value simultaneously, we observe a beneficial reinforcement cycle. Economic value, which goes beyond immediate effects on profits, involves considering future market trends and regulatory changes, thereby contributing to the endurance of a business and its competitive edge. It is crucial to view economic value in conjunction with the social dimension, as our empirical findings have suggested the interdependence of these two factors, particularly regarding workers' well-being.

Realization of value reinforces commitment to collaboration, fortifying relationships among actors, thereby fostering a self-reinforcing cycle. Actors, particularly upstream entities, transition from a reactive stance to a proactive one concerning circularity. This positive feedback loop plays a pivotal role in establishing the adopted CE practices as industry norms, materializing the concept of "circular lock-in". In this state, actors deviate from the linear "take-make-dispose" paradigm and embrace a circular mindset.

While evidence of this positive loop is discernible for Narrowing and commencing for Closing, challenges persist for Slowing, especially in manufacturing countries. However, progress is underway with external actors like the European Union influencing values through policies like carbon taxing.

A holistic perspective is indispensable for a truly sustainable transition, preventing the creation of "blind spots" that inadvertently may introduce new challenges in the attempt to solve others. Understanding the interactions among subsystems is instrumental in discerning whether the emergent practices will evolve into industry norms or face resistance within the system.

8 Conclusion

In this thesis, we tried to answer the research question, *"How can collaboration drive the adoption of Circular Economy in Textile Industry?"*.

To answer our research question, we build on the conceptual framework *System of Systems* by Iacovidou et al. (2020) by incorporating three dimensions of collaborative dynamics identified in the literature on collaboration for sustainability by Vazquez-Brust et al. (2020). The CE literature allowed us to be more specific in our investigation by adopting its three main strategies: Narrowing, Slowing, and Closing. Incorporating collaborative dynamics in our framework provided the necessary granularity to identify and analyze different types of collaboration and investigate their impact on the adoption of Narrowing, slowing, and closing strategies. This approach further enabled us to structure our research and present the findings and subsequent discussion. Employing our theoretical framework, we investigated (1) the impact of collaboration on CE adoption and (2) the impact of the adoption of CE strategies in the *Processes* subsystem on the *Values* subsystem and, subsequently, the impact of *Values* on the *Actors* subsystem.

In the first part, we discussed how collaboration can be orchestrated to overcome the barriers to Narrowing, Slowing, and Closing identified during our empirical study. Our investigation showed that driving the adoption of Narrowing practices requires closing knowledge gaps, overcoming incentive-related barriers that hinder the necessary investments, and creating a conducive environment. To overcome the first barrier, actors adopt a relational type of collaboration to build trust and engage in informal knowledge-sharing and best practices-sharing activities based on common interests; these collaborative interactions can be centralized or decentralized ad-hoc arrangements. A combination of captive and relational collaboration helps to overcome incentive-related barriers. Finally, centralized collaborations create the necessary power dynamics to create a conducive environment and lobby for it when support from external actors, such as governments, is required. For a successful adoption of Slowing practices, the findings highlighted a need for a shift in consumers' attitudes, a focus on circular product design and manufacturing, and establishing a sustainable fashion cycle. Centralized collaborations avoid incoherent and inconsistent communication from different actors that could lead to confusion among Consumers; instead, they facilitate coordination for a combined effort from internal and external actors to exert a more significant influence on Consumers. Similar to the case of the incentive-related barriers to Narrowing practices, the realization of circular designs warrants a sequential combination of captive and

relational approaches with Manufacturers that must share the brands' vision of crafting long-lasting garments and adapt their manufacturing processes accordingly. As for changing consumers' attitudes, creating a sustainable fashion cycle requires coherent and consistent action from multiple internal and external actors, with centralized collaborations that seem to be a suitable option.

Furthermore, to close the loop successfully, we have discussed that it is essential to establish standards for the end-of-life management of textiles, encompassing collection and sorting, while enhancing the viability of recycling processes. Our investigation showed how formal collaborations can be a valuable means to establish standards and ensure the correct management of products at the end of their life. At the same time, centralization facilitates connections among Recyclers, Brands, and Manufacturers, fostering collective efforts to improve recycling methods and, consequently, promote recycled garments.

Finally, we introduced the concept of "circular lock-in". We discussed how these collaborative dynamics could trigger a causal loop among Actors, Processes, and Values subsystems. We argue that this loop can lead to a) a systemic resistance to further adoption of CE strategies and related practices or b) a positive self-reinforcing loop resulting in circular strategies and related practices becoming the norm.

In conclusion, if well-designed, collaborations can effectively drive CE. However, a holistic approach that considers the entire system and the relevant stakeholders, both internal and external, is required to have a proper transition towards circularity and create what we call a "circular lock-in".

8.1 Theoretical Contributions

This study explored the significance of collaboration in adopting CE by taking a holistic approach and analyzing various forms of collaboration in connection with the three key CE strategies. Additionally, the research delved into the impact of CE adoption on relevant stakeholders and how it might shape their willingness to accept or reject related practices. Aligning with the expected contribution from section 1.2, the study (1) expands the literature on CE and provides a deeper and more nuanced understanding of how different types of collaboration can be a major driver in the adoption of CE. In particular, we answer the call from Aarikka-Stenroos et al. (2022) and Aarikka-Stenroos et al. (2021) by conducting a richer case study with data from multiple actors, both internal and external to the value chain, thus enhancing a system-level understanding of collaborations for CE and providing structure to what we, and previous researcher like Ingstrup et al. (2021), have perceived

as a rather fragmented and only recently and sporadically studied field of research. Furthermore, this research (2) expands the *System of Systems* conceptual framework by Iacovidou et al. (2020) to examine a specific type of interaction – collaboration - and applies it to a concrete context, thus illustrating how it can be applied at a practical level. As a result, this framework combines holism and reductionism, allowing for granular analysis of collaborative interactions among actors while maintaining a system-level perspective. This allows the authors (3) to apply System thinking in an empirical investigation. In contrast, until now, most of the adoptions of System thinking and holistic approaches are still conceptual (Balanay & Halog, 2021).

8.2 Practical Implications

The findings of the study may hold implications for industry practitioners. Firstly, practitioners can utilize our framework as a reasoning tool to analyze past collaborative interactions and try to understand why some collaborations succeeded while others failed. Secondly, they can reason about how they may use collaborations to facilitate the adoption of CE in their environment while avoiding blind spots that could hinder the acceptance of proposed practices. Our framework can serve as a valuable collaboration assessment tool for practitioners. It aids in determining the most suitable forms of collaboration for a specific practice, considering various factors such as the practice's nature, the potential partners involved, potential barriers, and the impact on the values held by all relevant stakeholders. This holistic approach ensures that the practitioners consider the impact of a practice on all the other relevant stakeholders.

In addition, with the appropriate modifications, our framework can be effectively utilized to analyze collaborative interactions at different levels of analysis - micro, meso, or macro. Indeed, the *Actors* subsystem may comprise organizations, individuals, industries, and potentially even entire nations. Specific to our empirical context, the study provides insights into the challenges faced by the textile industry and how practitioners may adopt specific types of collaborations to overcome them. Moreover, the study emphasized how the contextual conditions pose specific obstacles that require collaboration and coordination among internal and external stakeholders. In particular, differences in economic development and social welfare levels across manufacturing and consuming countries can lead to varying priorities and needs. Consequently, differing perspectives on the same practices may arise among different stakeholders, thus hindering their adoption.

8.3 Limitations

Certain limitations should be considered when evaluating this research. First, due to our methodological choice, caution should be exercised while transferring our findings and framework to a context different from that of the textile industry. One additional constraint pertains to the accessibility of data. Several interview requests were declined, resulting in a deficiency of first-hand accounts from specific individuals in our data pool. Notably, we were unable to conduct interviews with government officials. As a result, we have had to rely on information provided by collaborating actors and corroborate it through secondary research to compensate for this limitation.

Additionally, it should be noted that despite agreeing to participate in interviews, textile waste collectors declined to be recorded. Unfortunately, this may have resulted in missed opportunities for obtaining key insights, as the lack of transcription made it challenging to validate specific information. In both cases, we may have missed valuable insights and perspectives. Finally, we did not study the impact of CE adoption through collaboration on the wider system of Iacovidou et al. (2020) *System of Systems* conceptual framework presented in (3.1.3).

8.4 Future research

The authors hope this study will stimulate future research within the field, with more researchers adopting a holistic perspective in combination with reductionism in studying how the transition towards CE can be driven. In the follow-up research, the wider system can be studied with greater focus. To further strengthen the findings of this study, it would be relevant for future research to use quantitative methods to quantify the impact of each type of collaboration on Narrowing, Slowing, and Closing. Furthermore, it would be valuable to quantify the impact of CE strategies and practices on the triple bottom line and study potential tradeoffs among the three values. A quantitative study would make our findings and framework more robust and valuable for academia and practitioners.

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10 Appendix

10.1 List of barriers to CE adoption from literature review

Table 9: List of Barriers

Category	Barriers	References
Market		
Lacking economic viability of circular business models	Measuring the financial benefits of circular economy Financial risks Cannibalization Know-how access Low virgin material prices Lacking standardization (e.g. performance assessment, refurbishment products, materials) High upfront investment costs	Govindan & Hasanagic (2018); Kazancoglu et al. (2020); Ki et al. (2020); Kirchherr et al. (2018); Mishra et al. (2022); Mont et al. (2017); Ritzén & Sandström (2017); Saccani et al. (2023)
Regulatory		
Lacking policies in support of a CE transition	Obstructing laws and regulation Lacking global consensus Lack of incentives for Circular Economy	Govindan & Hasanagic (2018); Kazancoglu et al. (2020); Ki et al. (2020); Kirchherr et al. (2018); Mishra et al. (2022); Mont et al. (2017); Ritzén & Sandström (2017); Saccani et al. (2023)
Cultural		
Lacking awareness and/or willingness to engage with CE	Hesitant company culture Limited willingness to collaborate in the value chain Internal resistance to change (‘linear lock-in’) Lacking consumer awareness and interest Missing exchange of information Limited circular procurement	Kazancoglu et al. (2020); Kirchherr et al. (2018); Majumdar et al. (2022); Mishra et al. (2022); Mont et al. (2017); Rizos et al. (2016)

Technological

Lacking technologies to implement CE	Lacking the ability to deliver high-quality remanufactured products due to limited availability and quality of recycled materials Tracking of recycled materials limited circular designs Lack of data about the impact of CE practices Data privacy and security Integration into production processes	Alves et al. (2022); Govindan & Hasanagic (2018); Ki et al. (2020); Kirchherr et al. (2018); Majumdar et al. (2022); Mont et al. (2017); Ponnambalam et al. (2023); Ritzén & Sandström (2017)

10.2 Co-creation workshop

Prof Ranjula Bali Swain and Associate Professor Susanne Sweet, Research Directors of Centre for Sustainability Research Department of Marketing and Strategy, Stockholm School of Economics, organised a co-creation workshop on "circular economy and global value chains in the textile industry". The co-creation workshop took place at the 7th Nordic Development Research Conference (NorDev) on 22 August 2023 at Uppsala University. The workshop investigates innovative circular business models and processes that address new technologies, policy needs and the complex value chain of the textile sector between Sweden and the developing countries engaged in production.

80 per cent of the EU textile consumption-related emissions are in production countries located in the developing world. The overall objective of this workshop will be to study the innovative CE business models and processes in the Swedish textile value chain and analyse how they can contribute towards a regenerative growth model to avoid inefficient resource use, reduce consumption footprint, and create new business opportunities within the planetary boundaries. The textile sector is identified as a priority sector in the European Green Deal and the New Industrial Strategy for Europe (COM, 2020), and the 2020 EU Circular Economy Action Plan (CEAP).

Table 10: Participants in co-creation workshop

Domain	Position
Brand 1	Director of Sustainability
Brands 2	Vice President Sustainability
Brands 3	Head of Sustainability
Fiber producer (Manufacturer 1)	Head of Application & Sustainability
Recycler 1	Vice President Supply Chain & Sourcing
Policy 1	Director - Sustainability
Academia 1	Professor
Academia 2	PhD scholar
Academia 3	PhD scholar
Academia 4	PhD scholar

The main topics were as follow:

1. Identify opportunities and barriers in implementing CE.
2. Identify business/market needs to support the implementation and scaling of circular economy.
3. Identify policy needs to support the implementation and scaling of circular economy.

In the co-creation workshop, the participants we divided into three smaller groups and asked to brainstorm on the topics. We support the professors during the workshop by being part of a group as silent observers and taking notes.

10.3 Interview guide

The interviews conducted were semi-structured and Interview guid was mainly to support the interviews to organise and guid the interview process to ensure all information's needed are collected. Both of us were present in all interviews. While one took the lead the other kept track of the discussion using interview guide. We were careful not to break the rhythm of interviewees and used follow-ups questions, probing questions and clarifying question at the end to ensure the completeness of data collection. This enabled us to ensure the exhaustive collection of data without breaking the natural reporting of interviewees. Please find below the Interview guide

Name:
Designation:

Instruction: Use very simple language, especially with manufacturers.

Introduction

1. Request permission to record.
2. Briefly explain the research purpose
3. Tell me about your role in the company.
    1. Specific designation (for our reporting need)
2. Tell me about the company.

Map the process.

3. Tell us more about your processes.
    1. What all do you need for your process?
        1. What resources are consumed?
    2. From whom or where do you get the resources?
        1. Do you track how much you consume?
    3. What is the output of your process?
    4. Is there waste?
        1. What do you with your waste?

Map the stakeholders.

4. Who are the major internal and external stakeholders in your value chain
    1. Who are your suppliers (internal or external; level of vertical integration)
        1. How do you work with them?
        2. How are orders placed?
        3. What all documents usually are required (sustainability certificates etc.)
    2. Do you plan for the future?
        1. Is it collaborative planning?
        2. How do you plan for investments?
        3. Which factors influence your investments' decisions?
        4. If it does not come out, explicitly ask if they have some co-investment activity with Brands or other actors
    3. How do you work with your customers?
        1. How do you work with them?
        2. How are orders placed?

3. What documents are usually required (sustainability certificates etc.)

4. Do you plan for the future?
    1. Is it collaborative planning?
    2. How do you plan for investments

5. Factors influencing investments.
    1. If it does not come out, explicitly ask if they have some co-investment activity with Brands or other actors.

Map the Values

6. What do you see as the outcome of your companies' activities?
    1. Look if Economic, Social, and Environmental values come out. Also, look for additional values.
    2. Probe in each of the values.
        1. What are the factors that influence these values?
        2. Are you satisfied with these values?
        3. What more can be done?
            1. What help, support or assistance from other actors can be useful?

7. What are the major challenges you face?
    1. How do you tackle these challenges?
        1. Who can support you to overcome these challenges?
        2. How do you stay updated regarding latest trends?
            1. Are you part of any associations?
            2. What are the benefits?
        3. Are there any other actors who influence your way of working (e.g., policy makers)
    2. Are there any other actors who collaborate with you(e.g., post-industrial waste collectors)
    3. Are there any other actors you would like to communicate/collaborate with?
        1. If it does not come out, explicitly mention that by actors we mean also external ones (like NGOs)
        2. Are you able to collaborate with them?
            3. How?
            4. If negative response, why?

8. Do you think the current textile industry needs improvements? (Look if sustainability or circularity comes out automatically)

1. Are CE practices (recycling, remanufacturing and so forth) needed in the textile industry? Why/Why not?
2. Please tell us how a circular textile system would look like for you.
3. Do you think these circular practices will adoption in near future?
    1. If no or doubtful: Why do you think it is like that?
        5. Look for evidence for barriers and once presented prob more into them.
        6. Try to understand the most important barriers for him/her.

9. Barriers
    1. Talk more about each of the barriers (Iterative)
        1. Why is there the barrier.
        2. Prob to understand who is responsible for each barrier.
    2. How can these barriers be removed?
        1. What can you do about it?
        2. Is support required?
        3. If yes, from who?
        4. Can you give an example where any such situation where you overcame barriers by collaborating with others?

10.4 Pilot study

Table 11: Participants in the pilot study

Actor	Position	Organisation	Interview mode
Actor A	Partner	Manufacturer A	video Call
Actor B	Founder	Manufacturer B	video Call

Piolet interview was conducted with two Manufacturers from India for the following reasons.

1) During the co-creation workshop, we were able to interact with multiple stakeholders from Sweden. However, considering the fact that majority of manufacturing happens in countries in global south like India, we were missing their perspective. We wanted to have an overall perspective before starting our field study which was planned to be in India.
2) We used the pilot study to test our understanding from literature review and our interview guide.

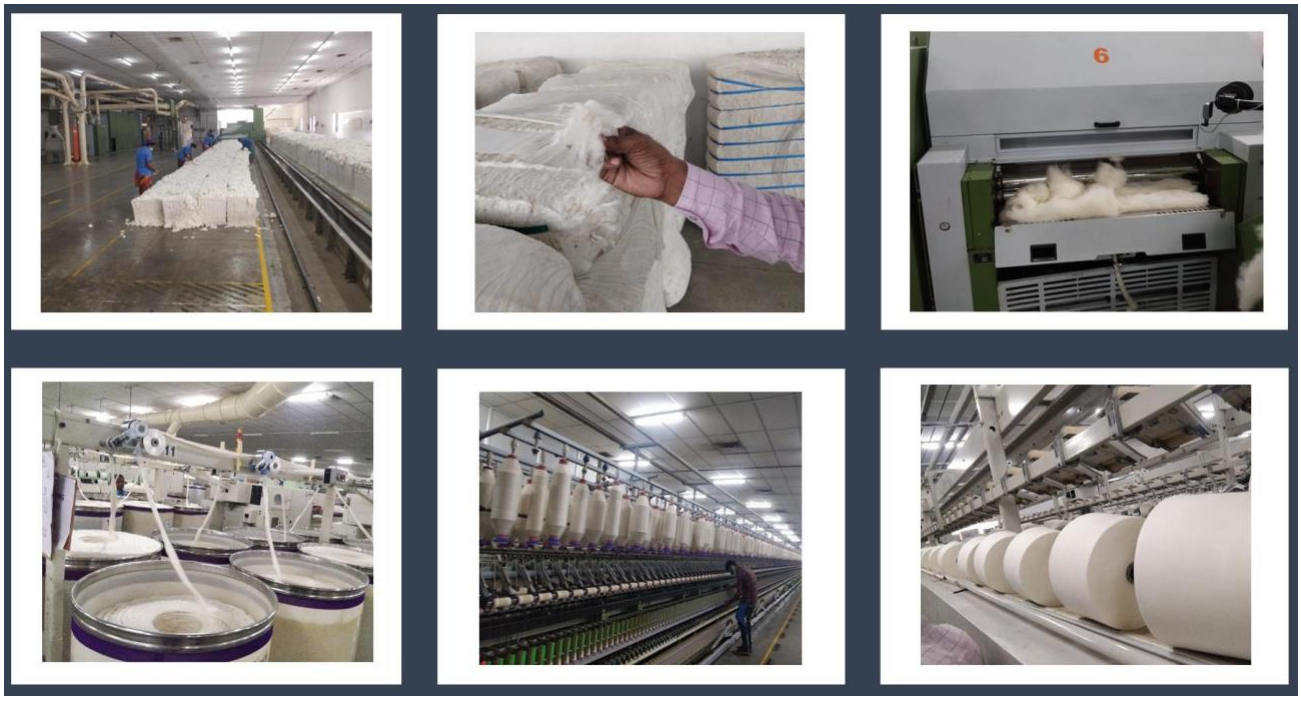
10.5 Main study

Table 12: Participants in the main study

Actor	Position	Organisation	Interview mode
Actor 1	Director	Recycler 1 (R1)	video Call
Actor 2	Owner	Recycler 2 (R2)	video Call
Actor 3	Vice President Supply Chain & Sourcing	Recycler 3 (R3)	video Call
Actor 4	Head of Sustainability	Brand 1 (B1)	video Call
Actor 5	Director Sourcing	Brand 2 (B2)	video Call
Actor 6	Senior sustainability developer	Brand 3 (B3)	In Person
Actor 7	Country Manager, India	Brand 3 (B3)	In Person
Actor 8	Vice President Sustainability	Brand 3 (B3)	video Call
Actor 9	Sourcing Manager	Brand 4 (B4)	video Call
Actor 10	Director	Manufacturer 1 (M1)	In Person
Actor 11	HR, Compliance and Sustainability Manager.	Manufacturer 1 (M1)	In Person
Actor 12	HR & Compliance Manager	Manufacturer 2 (M2)	In Person
Actor 13	Sr. Merchandizer (Kappahl KAM)	Manufacturer 2 (M2)	In Person
Actor 14	Group Sustainability & Compliance Manager	Manufacturer 3 (M3)	In Person
Actor 15	Director Marketing	Manufacturer 4 (M4)	In Person
Actor 16	Compliance Manager	Manufacturer 5 (M5)	In Person
Actor 17	Vice President Operations-Spinning	Manufacturer 5 (M5)	In Person
Actor 18	Senior manager HR & compliance	Manufacturer 6 (M6)	In Person
Actor 19	Sustainability Compliance Manager	Manufacturer 6 (M6)	In Person
Actor 20	Associate Vice-President	Manufacturer 6 (M6)	In Person
Actor 21	Managing Director	Manufacturer 7 (M7)	In Person
Actor 22	Executive Director	Manufacturer 7 (M7)	In Person
Actor 23	Executive Director	Manufacturer 7 (M7)	In Person
Actor 24	Senior member	Textile association 1 (T1)	In Person
Actor 25	Organiser knit wear export fair & a Manufacturer	Textile association 1 (T1)	In Person
Actor 26	Owner	Venture Capitalist (V1)	video Call

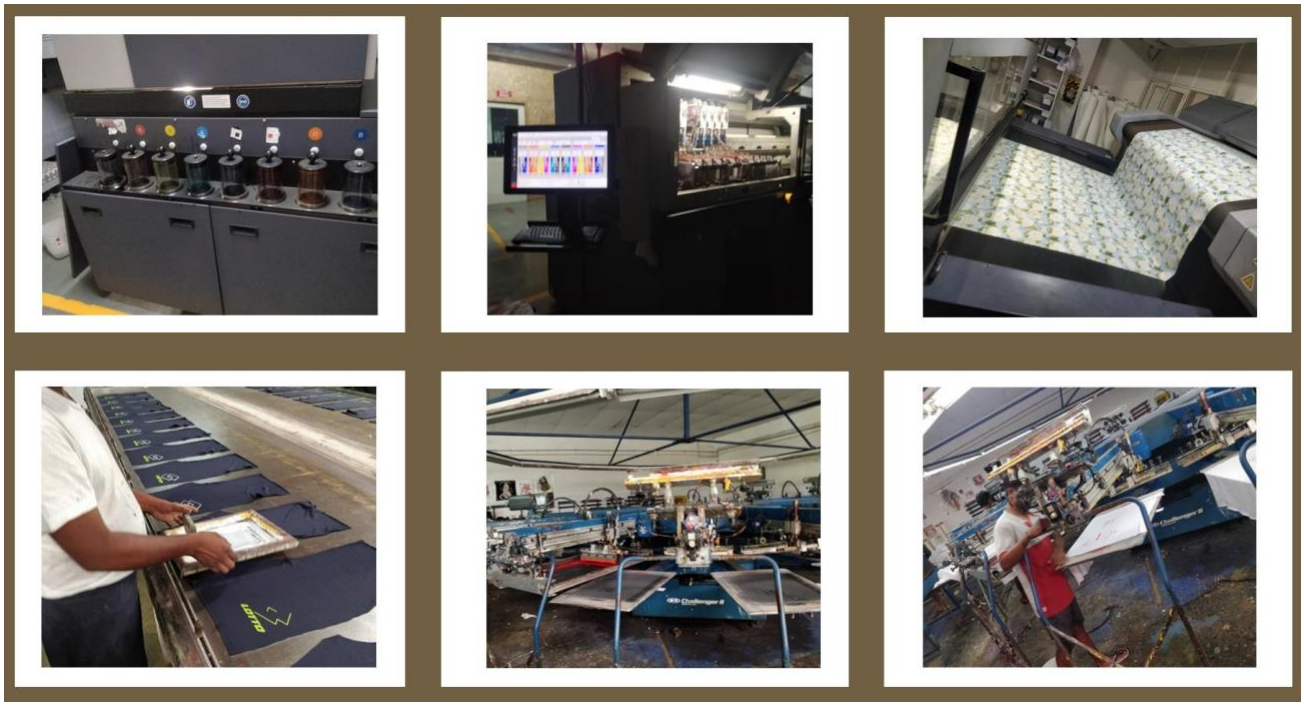
Actor 27	Innovation Associate	NGO 1 (N1)	video Call
Actor 28	Program Manger	Public business institution (PB 1)	In Person
Actor 29	Regional lead- Energy and sustainability	Consultant (C1)	In Person
Actor 30	Senior Adviser	Embassy (E1)	In Person

10.6 Pictures

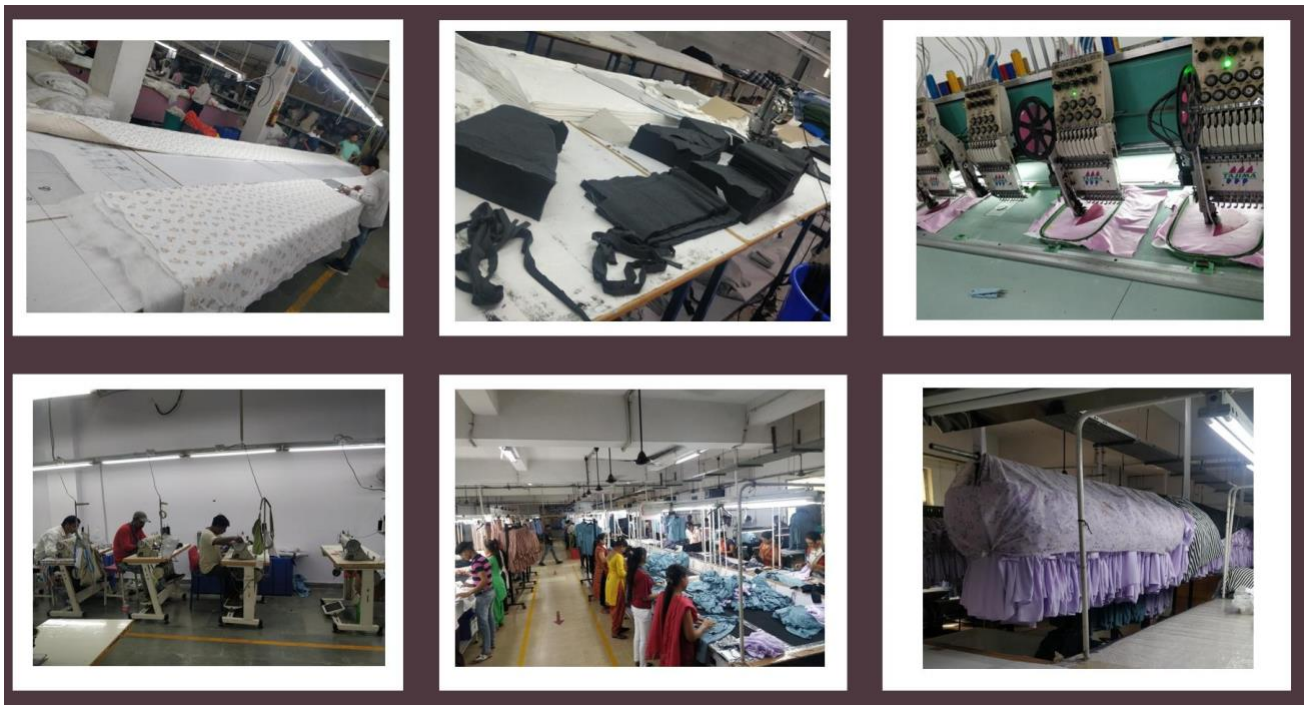


Pic 1: Fiber to Yarn

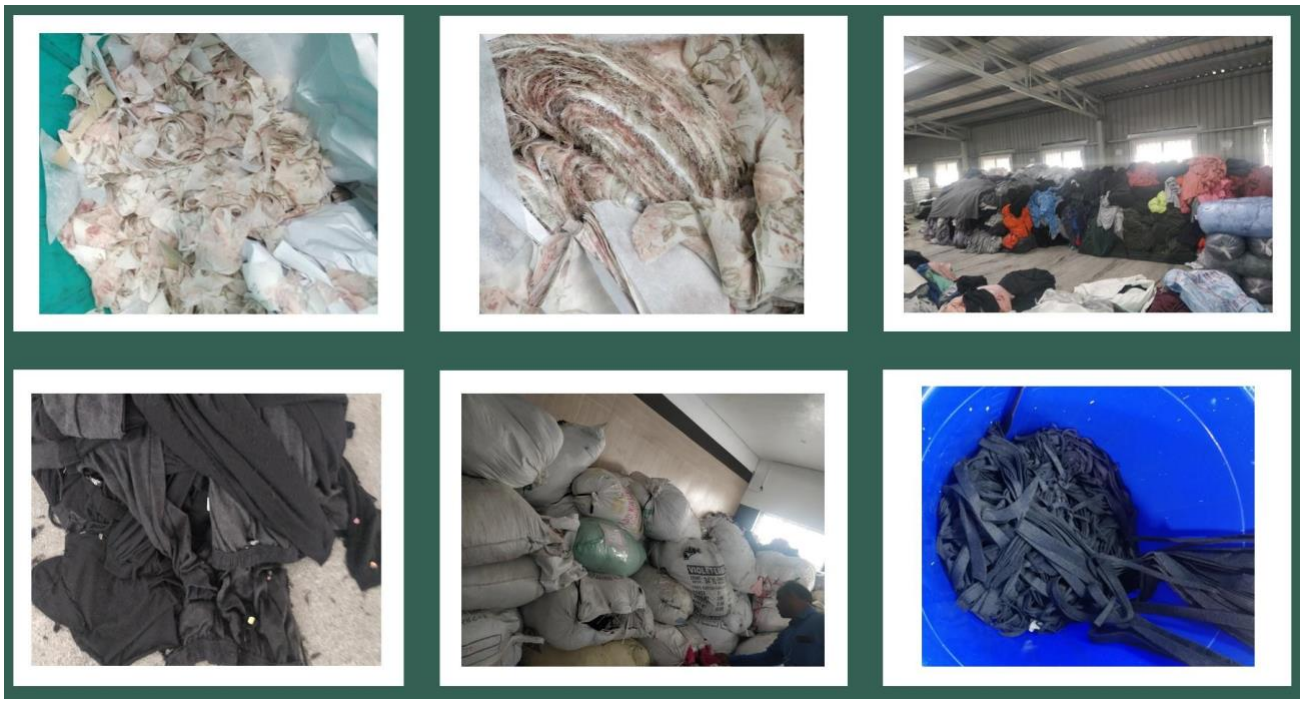
Pic 2: Yarn to fabric



Pic 3 Textile Printing



Pic 4 Cut to Pack



Pic 5 Post Industrial cutting waste

10.7 Enhancing writing tools

While writing this thesis, the authors utilized the Premium version of Grammarly, an online writing assistance tool, to enhance the correctness of the text. The use of Grammarly contributed to the overall improvement of the text quality.