CIRCULAR IS THE NEW BLACK

A multiple-case study on circular innovation in fashion

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SHEA HAGGERTY

CIRCULAR IS THE NEW BLACK

A multiple case study on circular innovation in fashion

BY

Shea Haggerty

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Un Aperçu

Executive Summary

The fashion industry's transition to a **circular economy (CE)** is crucial to mitigating its devastating environmental impact. Currently, the fashion industry accounts for 4% of global greenhouse gas emissions, more than aviation and shipping combined. This figure is projected to rise by 2.7% annually without increased decarbonisation efforts. To reverse this trend, brands and retailers must adopt circular processes enabled by technological innovations that promote sustainable manufacturing, circular garments, and responsible consumer practices. Within the fashion industry, **circular-born start-ups (CBSs)** play a key role in the circular transition by introducing **circular innovations (CIs)** that close, slow, or narrow resource loops. However, CBSs face significant challenges in bringing their CIs to market, and the literature on this topic is limited. This research aims to fill that gap by answering the main question: *"How do CBSs introduce their CIs within the fashion and textile industry?"* The study addresses three sub-questions: identifying the circular strategies and value propositions CBSs use, the activities they engage in, and the main factors driving or blocking CI introduction.

The research design took the form of a **multiple-case study**, and was conducted using the theoretical framework of **Technological Innovation Systems (TISs).** The empirical context of the research is the French fashion industry, and 9 cases were conducted among French CBSs, shown on the left. The data used within the cases was collected with **semi-structured interviews** and primary data sources, such as news articles and podcasts. On top of the interviews conducted with the CBSs, 2 expert interviews were conducted to triangulate case study data and act as an additional perspective. The 9 CBSs included within this research encompass a wide range of CIs, spanning from recycling technologies to Care & Repair solutions.

The data analysis of this study consisted of coding the interview- and additional primary data on the CBSs. The main findings from this research describe how CBSs introduce their CIs to the fashion and textile industry through a combination of strategic positioning, and processes and interactions with industry stakeholders. CBSs employ **circular strategies** (closing, slowing, and narrowing resource loops) and **circular approaches** (e.g., recycling, repair) to position their CIs. They communicate their value propositions through a combination of tangible benefits (e.g. operational efficiencies, traceability) and intangible benefits (e.g. facilitating entry to the CE). This clear positioning helps CBSs align with industry expectations and attract brands, investors, and other stakeholders. It was found that different CBS typologies (e.g. industrial vs. non-industrial) results in different collaborations and processes, and their experienced barriers and drivers can vary in their impact. However, essential interactions that the majority of the sampled CBSs encountered, were identified to be with **brands, suppliers, ecosystem associations and research centres.** These interactions facilitate CBSs' market entry, knowledge development and resource mobilisation. These interactions help CBSs adapt their CIs to ensure proper market fit. Challenges such as regulatory compliance, market perceptions, and complex collaboration processes are addressed through continuous R&D, pilot projects, and leveraging regulatory incentives. CBS typologies, such as industrial vs. non-industrial CBSs, strongly influence which exact combination of processes and interactions a CBS partakes in. **Six inducement mechanisms** (e.g., regulatory support, CE awareness) and **six blocking mechanisms** (e.g., data gaps, lack of stakeholder commitment) influence CI introduction.

The **contributions** of this research include a deeper understanding of the CE with respects to the fashion industry, and a contextualisation of the concept of CIs within fashion. Furthermore, it provides rich empirical insights that facilitate a deep understanding of how CBSs operate, communicate and interact within the fashion industry. Lastly, this research adds to the TIS literature by applying a relatively novel actor-oriented TIS approach. **Practical implications** encompass how insights from this research can help CBSs learn from each other and enhance collaborations. Policymakers and other industry stakeholders can better support CBSs by understanding their challenges and strengths, which can drive innovation within the industry as a whole. Lastly, the role of social and societal implications within the concept of CIs within fashion, touched upon throughout this research, can increase the urgency for both CBSs and brands to take responsibility for the social and societal implications of their innovations or supply chains.

Keywords

circular innovation, circular-born start-ups, fashion and textile industry, technological innovation system

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Nomenclature

List of Abbreviations

Abbreviation	Definition
BM	Business Model
BMI	Business Model Innovation
CE	Circular Economy
CBS	Circular-Born Startup
CI	Circular Innovation
CIF	Circular Innovation Fund
CBM	Circular Business Model
CBMI	Circular Business Model Innovation
DPP	Digital Product Passport
EI	Eco-Innovation
CEAP	Circular Economy Action Plan
GHG	Greenhouse Gases
IP	Intellectual Property
LCA	Life Cycle Assessment
PEF	Product Environmental Footprint
TIS	Technological Innovation System
RQ	Research Question
SBM	Sustainble Business Model
SQ	Sub-Question
VC	Venture Capital
VP	Value Proposition
VR	Virtual Reality

01 Introduction

Anna Wintour, editor-in-chief of Vogue since 1988 and branded by many as 'the most powerful person in fashion', has decided which style, colour or print was the *new black* for decades (Weiss, 2014). However, with the rise of social media, micro trends have taken over part of her say-so in the fashion world. **Micro trends** are sudden peaks of popularity in specific garments (Harvard Political Review, 2023). To keep up with these micro trends, fast fashion brands, such as H&M and Zara, operate in extremely short design and production cycles - resulting in cheap, low-quality garments. The rapid overturn of trends has given rise to ultra-fast fashion brands, such as Temu and Shein, who release up to 2000 (!) new styles every day (Rest of World, 2021). Unfortunately, the sped-up trend cycles are not limited to cheaper apparel brands - since 2010, the number of fashion weeks has more than doubled, implying luxury brands have drastically increased the frequency of launching new collections (Misani & Capello, 2017; Opmeer & Van Eijk, 2020).

The fashion industry is renowned for its cutting-edge creativity and innovation. However, the pressure to become more sustainable has formed a stark contrast with the industry's objective to stay on top of avant-garde creation (Alhaddi, 2015; Medium, 2023). The pressure for the fashion industry to radically overhaul its behaviour is justified: the **environmental and social impacts of the industry are disastrous**. Currently, the fashion industry accounts for 4% of global greenhouse gas (GHG) emissions, which is more than the shipping and aviation industry combined (McKinsey&Company, Global Fashion Agenda, 2022). Textile dyeing alone is responsible for more than 20 % of the earth's water pollution, and each year, approximately 500 thousand tonnes of microplastics are introduced to our environment due to the wearing and washing of synthetic textiles (European Environment Agency, 2022). Other than environmental damage, the fashion industry is responsible for social injustice, predominantly amongst employees who work further up in the supply chain where unfair wages and threats to social and physical safety are, sadly, not uncommon (Clean Clothes Campaign, 2022).

In recent years, the interest towards the **circular economy (CE)** has risen. Although numerous definitions exist, the CE can be described as *"a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling"* (Geissfoerfer et al., 2017, p. 766). The CE opposes the dominant linear 'make-take-waste' model, and is commonly viewed as a promising condition or strategy for sustainability (Geissfoerfer et al., 2017). **Circularity within fashion** includes closed-loop supply chains and design for longevity and durability to ensure resources are kept in the cycle for as long as possible (Cramer, 2022; Ostermann et al., 2021). A study by McKinsey & Company estimates that circular business models alone could enable the fashion industry to cut emissions by 143 million tons by 2030 (McKinsey&Company, Global Fashion Agenda, 2022). Other than holding the potential to decrease the industry's impact on the environment, the CE is estimated to pose an economic opportunity of $560 billion US dollars (Ellen MacArthur Foundation, 2021).

The notion that circularity can improve the sustainability of the fashion industry is widely shared amongst policymakers as well. The European Union (EU) has identified textiles[1] as a priority product category within its 2020 new Circular Economy Action Plan (CEAP). With this CEAP, the EU wishes to prevent and reduce waste to keep resources in the EU economy for as long as possible (European Parliament, 2023). The CEAP is not the only international accord pushing for more circular and sustainable practices: the transition to a CE would largely contribute to multiple **international goals**, such as the EU's 2050 Green Deal and the majority of the UN's Sustainable Development Goals (European Commission, 2023; European Environment Agency, 2019).

[1]Garments account for 60% of total textiles (Ellen MacArthur Foundation, 2021)

1.1. Problem Statement

In the next decade, the fashion industry must halve its GHG emissions to avoid vastly exceeding the 1.5 degree global warming limit (McKinsey&Company, Global Fashion Agenda, 2022). The same study states that brands and retailers are the key drivers in this, and will need to drastically increase their decarbonisation efforts to limit their threat to our climate. Technological innovations are a major stakeholder in transforming the way brands manufacture or operate, or influencing the way we consumers interact and care for their clothing. These innovations can enable circularity within fashion, contributing to the creation of *"new materials, machines and equipment"* that result in more sustainable garment production or recycling efforts (Ikram, 2022; Ostermann et al., 2021, p. 8).

When an innovation closes, slows or narrows resource loops by accounting for the end-of-life phase and is resource-efficient, has positive economic, environmental and social impact and is sustainable, we speak of a **circular innovation (CI)**. Examples include Belgian start-up Resortecs' heat-disintegrating thread for efficient textile recycling (Resortecs, 2023), and Living Ink's process to transform agricultural biomass waste into carbon-negative textile pigments (Living Ink, 2024). When start-ups are founded from the objectives CE principles, focusing on closing, slowing or narrowing resource loops, we speak of **circular-born start-ups (CBSs)** (Ostermann et al., 2021; A. Salmi & Kaipia, 2022). CBSs exploit the flexibility of the start-up stage to innovate, contrasting with large incumbents who often struggle with path-dependency and are cautious about launching large-scale innovations (Todeschini et al., 2017). CBSs can address and adapt to unsustainable trends, playing a key role in developing innovations that can accelerate the transition to a CE (N. Bocken et al., 2018; R. Salmi, 2021; Weissbrod & Bocken, 2017). However, the fashion industry is notoriously challenging for start-ups due to seasonal demands, fierce competition, and a lack of collaborative culture, resulting in low start-up success rates (Malem, 2008; Riegels, 2011).

During my research, Renewcell, widely acknowledged as one of the most promising CBSs in fashion, declared its bankruptcy (Business of Fashion, 2024). Renewcell had developed a technology to recycle textile waste into circulose®, a dissolving pulp from which recycled fibres can be produced (Renewcell, 2023). This announcement shocked the fashion industry, especially since Renewcell's technology had been successfully scaled commercially (Business of Fashion, 2024). The Renewcell bankruptcy is a real life example of how difficult of an environment the fashion industry is for CBSs to thrive in. Although the bankruptcy gained significant attention in the media, with many parties trying to explain how it could have happened, little is known about the challenges CBSs face when introducing their CI to the fashion industry.

In recent years, the body of literature on circularity-oriented innovations within the fashion industry has grown (N. Bocken et al., 2016; Ostermann et al., 2021; A. Salmi & Kaipia, 2022; Todeschini et al., 2017; Weissbrod & Bocken, 2017). However, these studies tend to focus on business model innovations (e.g. resale or rental platforms), and fail to generate insights on CIs in particular, which focus on novel products or processes. Furthermore, there is a lack of attention for start-ups within the fashion industry, as linear incumbents[2] or SMEs are often the focal actor in research on the adoption of circular practices (Franco, 2017; Henry et al., 2020; A. Salmi & Kaipia, 2022). Lastly, although the essential role of technology within the transition to the CE in fashion is widely acknowledged (Dissanayake & Weerasinghe, 2022; Huynh, 2021; Ikram, 2022; Todeschini et al., 2017), empirical insights on how these technological novelties are introduced within the fashion industry are limited. Especially, the introduction of CIs by CBSs forms a significant gap in the literature. This presents a great opportunity for investigation, as actor-oriented research could help CBSs and policymakers in understanding how and why some CIs come to succeed in the fashion and textile industry, and why others don't. The latter can subsequently provide valuable information for CBSs and inform policy recommendations that could facilitate the introduction of CIs by CBSs in fashion.

The urgency of the transition to a CE cannot be overstated. With the rising global middle class, the fashion industry's GHG emissions are projected to reach nearly 3 billion tonnes annually by 2030, a staggering 2.7% yearly increase (McKinsey&Company, Global Fashion Agenda, 2022). We won't be able to turn this growth trajectory around unless we embrace the innovative solutions from CBSs, who hold the potential to make significant impact.

[2] A linear incumbent is a company with significant market share in an industry, that operates via the traditional 'take-make-waste' model.

1.2. Research Objectives and Questions

Employing a qualitative multiple-case study within the empirical context of the French fashion industry, this research aims to explore how CBSs introduce their CIs within the fashion and textile industry. To effectively achieve this, three research objectives are formulated.

As previously mentioned, CBSs are start-ups that were founded on the notion of the CE principles. However, no single CBS can be fully circular by themselves, and CBSs can contribute to circularity in different ways, using different **circular strategies** (Henry et al., 2020). To understand how a CBS introduces their CI to the fashion industry, it is essential to understand their circular strategy, as this provides the framework within which their value propositions are developed and communicated. In turn, CBSs rely on their value propositions to clearly demonstrate the added value of their CIs, especially compared to less sustainable options (Ramirez et al., 2014; Ranta et al., 2020). Value propositions are tools firms can use to articulate the innovation's tangible and intangible benefits to customers and stakeholders (McKinsey & Company, 2000). Since value propositions are deemed as essential in communicating the added value of CIs, the **first research objective** is to analyse how CBSs position their CBSs within the fashion and textile industry, in terms of their circular strategy and value proposition.

When further analysing the introduction of innovations in the context of the CE, it is vital to understand that **circularity cannot be achieved alone**, but requires the mobilisation of industry actors, policymakers and consumers (Mentink, 2014). From this observation, it makes sense to analyse the introduction of CIs with the fashion industry using a systems approach. A widely acknowledged innovation system within academic literature is the **Technological Innovation System (TIS)**, which is described as a *"dynamic network of agents interacting in a specific industrial area, under a particular institutional infrastructure and involved in the generation, diffusion and utilisation of technology"* (Carlsson & Stankiewicz, 1991, p. 93). This description reflects the fashion and textile industry, as it is a complex, fragmented system in which many parties along the supply chain interact. Taking an actor-oriented TIS approach allows us to keep CBSs as the focal actors within this research, but remain aware of the interactions and processes between actors in the innovation system that shape market introduction and adoption of a CI. Empirical insights into the dynamic activities of CBSs allow us to better understand the processes and interactions that contribute to the successful introduction of CIs. Since this is highly valuable when exploring *how* CBSs introduce their CIs to the fashion and textile industry, the **second research objective** is to understand what processes and interactions CBSs engage in when introducing their CI.

As outlined in the problem statement, introducing CIs within the fashion and textile industry is not a walk in the park: start-up failure rates are high. To answer the main RQ, it is essential to understand the factors that drive or block the market introduction of CIs, as knowing the drivers and barriers helps explain why CBSs engage in certain processes or activities. Therefore, the **third research objective** is to identify which factors in particular hinder or drive CI introduction by CBSs.

The above illustrates how the three research objectives help reach the aim of the research. From the research aim, the following main research question was formulated:

> **How do circular-born start-ups introduce their circular innovations in the fashion and textile industry?**

To exhaustively answer the research question (RQ), while also fulfilling the research objectives described above, three sub-questions (SQs) are formulated:

> **SQ 1** How do circular-born start-ups position their circular innovations within the fashion and textile industry in terms of circular strategy and value proposition?
>
> **SQ 2** How do processes and interactions shape the market introduction of circular innovations by circular-born start-ups in the fashion and textile industry?
>
> **SQ 3** What factors drive or hinder the introduction of circular innovations in the fashion and textile industry?

SQ1 is directly identifiable through analysing case study data, while SQ2 and 3 require a back-and-forth approach between empirical case insights and TIS theory to rigorously and exhaustively answer the SQs. An in-depth overview of the methodolody of this research can be found in Chapter 3.

1.3. Relevance

In this Section, I set out to briefly highlight the relevance of this research within the broader academic landscape, within society, and its relevance to the Master of Technology (MoT) programme.

1.3.1. Academic Relevance

Academically, this research fills the literature gap as described under the 'Problem Statement': the empirical insights from the multiple-case study provide rich, in-depth information on how CBSs introduce their CIs to the fashion industry. Beyond contributing empirical data, this study synthesises the relatively novel term 'circular innovation' with existing literature on circular business models and circular business model innovation. This synthesis bridges theoretical concepts with practical applications, as I make an additional contribution of defining and contextualising CIs within the fashion and textile industry. Furthermore, this research enhances the existing body of literature on TISs by employing a relatively novel actor-oriented approach to assess processes and interactions. This approach provides a fresh perspective on how different actors within the innovation system interact and influence the introduction and adoption of CIs.

1.3.2. Social and Societal Relevance

This study provides empirical, and hence practical, insights into the processes and interactions CBSs engage in when introducing their CIs, what drives the introduction, and what blocks it. Firstly, the insights gained enhance industry know-how on circular solutions, their implications, and the key players behind these innovations. This improved understanding can help stakeholders in the fashion and textile industry both recognise and adopt circular strategies and innovations. Secondly, the findings can inform policy-making. Regulatory frameworks, such as the CEAP, aim to support the transition to a CE. Empirical data on the challenges and successes of CBSs in implementing CIs can guide the development of more targeted and effective policies. These policies, in turn, can provide the necessary support and incentives for CBSs, thereby accelerating the adoption of CIs across the industry.

1.3.3. Relevance to Management of Technology

One of the key challenges addressed by the MoT programme is *"how to leverage technological opportunities to fulfil our mission, objectives, and strategies"* (TU Delft, 2023, p. 1). The bankruptcy of Renewcell is a prime example of the complexity of harnessing technological opportunities in a bid to reach environmental objectives. My research investigates the influence of technology on strategies and business models, while highlighting the activities essential for its successful introduction. MoT has taught me that innovation cannot be studied in a vacuum, but must be examined within the context of industries and organisations. This research embraces this approach by considering real-life cases within the fashion industry, while and adopting a theoretically grounded approach by taking a systems' perspective on innovations.

1.4. Report Structure

Figure 1.1 shows the overall structure of this thesis. This Chapter introduces the topic of the thesis, along with the research problem, objectives and questions. Chapter 2 contains the theoretical background of this research, in which I provide more information on the CE, circularity within the fashion industry and TIS literature. Chapter 3 presents the methodology of this research, and Chapter 4 contains the literature review. This literature review aims to gather existing findings on challenges and opportunities CBSs face when introducing their CI in the fashion industry. The results of the literature review aided in the case design and overall structure of the report. Chapter 5 presents the results, and Chapter 6 contains the discussion. Lastly, Chapter 7 contains the conclusion of the research. Please note that an extensive report containing the findings from the case studies can be found in the **Case Report.** It is a supplementary document to this thesis, and aims to showcase the extent of work done on each case and shape the reader's overall understanding of the cases.

Figure 1.1: A visual overview of the structure of this thesis.

02 Theoretical Background

This Chapter provides a theoretical background for my research. Section 2.1 provides information on circularity within the fashion and textile industry, with industry specific examples to help understand the material flows relevant to this sector. Section 2.2 aims to synthesise circular strategies coined in the literature, while Sections 2.3 and 2.4 elaborate more on CIs and their links to business models. Lastly, Section 2.5 provides a theoretical background on the TIS, the theoretical framework of my research.

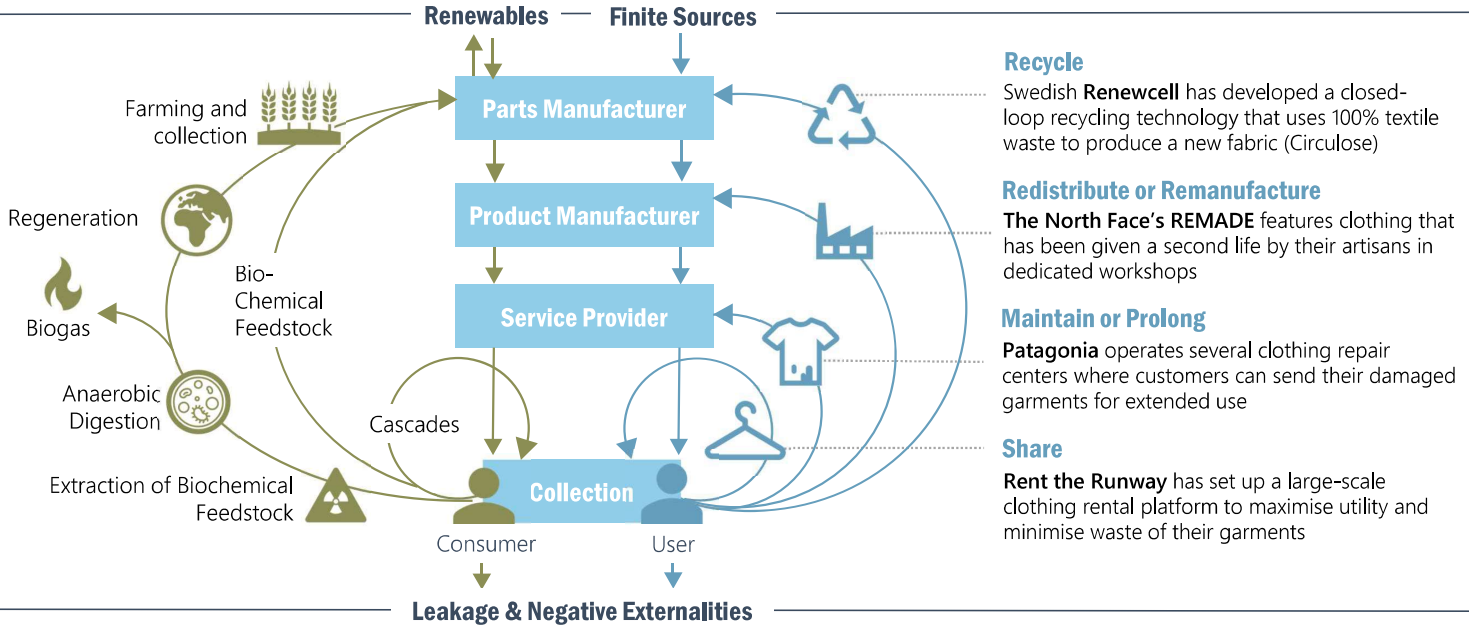
2.1. Fashion and the Circular Economy

The term 'Circular Economy' (CE) was first introduced in 1989 by Pearce and Turner (1989), when the laws of thermodynamics were used to describe the shift from the traditional open-ended system towards a circular economic system. Since, the CE has gained widespread attrition and is recognised as a solution towards sustainability due to its implied maximisation of resources and minimisation of waste, pollution and emissions (Ghisellini et al., 2016; Konietzko et al., 2020; Korhonen et al., 2018). Ellen MacArtur Foundation (2020) summarises that the CE is driven by design, and based on the principles of (1) waste and pollution elimination, (2) product and material circulation, and (3) the regeneration of nature. Being one of the largest polluters in the world, the fashion industry must undergo a paradigm shift to reduce its footprint. In the last decades, the industry has become a complex and fragmented global system operating mostly by the traditional 'make-take-dispose' model (Ellen MacArtur Foundation, 2015). Fashion obsolescence is accelerated by fast fashion, which pushes brands to search for technological efficiencies to reduce costs, produce high volumes, and drive prices down (Colucci & Vecchi, 2020; Kozlowski & Bardecki, 2015).

Dissanayake and Weerasinghe (2022, p. 29) have formulated circular fashion as *"a system that moves towards a regenerative model with an improved use of sustainable and renewable resources, reduction of non-renewable inputs, pollution and waste generation, while facilitating long product life and material circulation via sustainable fashion design strategies and effective reverse logistics processes".* A widely acknowledged framework for visualising such a circular system is the **Butterfly Diagram**, developed by Ellen MacArthur Foundation (2019). It distinguishes two cycles within the CE - the biological and technical cycle, which can be seen in Figure 2.1. The left-hand side of the diagram visualises the **biological cycle,** and represents materials that can be safely degraded by the earth. The cascade loop describes how products can be made from biological products already present in the economy - think of creating fruit leathers from pineapple leaves or apple pulp (Ananas Anam, 2023; Oliver Co, 2023). The extraction of biochemical feedstock involves the production of chemical products by bio-refineries, while the anaerobic digestion and regeneration describes the process of the microbial breakdown of organic matter which produces nutrients for the soil, which in turn allows for regeneration - increasing biodiversity, and enhancing the health of our soil (Ellen MacArthur Foundation, 2022a). The biological cycle mainly represents food items, but 100% natural textiles such as cotton and linen can also be included. A fully linen shirt, for example, takes just 2 weeks to decompose.

The **technological cycle** differs from the biological cycle as its products are made from finite materials, such as fossil fuels, as opposed to naturally renewable materials. Almost all synthetic fibres contain plastic, which is a product of the fossil fuel industry. Alarmingly, **more then 60% of clothing contains synthetic fibres**, such as polyester or polyamide (GreenPeace, 2016). Hence, most garments' life cycle is classified under the technological cycle. Although synthetic fibres are often very durable, they know many downsides. Firstly, their production requires massive amounts of energy - a staggering 40% of all fashion emissions stem from polyester manufacturing (Project Cece, 2022). On top of that, synthetics introduce microplastics to the environment and is one of the causes of plastic pollution in the ocean. Lastly, synthetic fibres are notoriously difficult to get rid of. Their decomposition can take more than 200 years, and burning them releases many polluting chemicals (Project Cece, 2022).

Figure 2.1: The CE Butterfly diagram, adapted from the Ellen MacArthur Foundation (2019) by adding fashion industry-specific examples (Patagonia, 2023; Renewcell, 2023; Rent the Runway, 2023; The North Face, 2024).



The Ellen MacArthur Foundation (2019) stresses that keeping products in the innermost loops of the technological cycle is most desired, as these steps protect the embedded value of the product. When a garment is shared via an online rental platform, for example, the garment's integrity is unaltered. Within each successive loop, the integrity of the garment is violated increasingly - from the repair of holes, to a refurbishment of the garment, to eventually completely disintegrating the garment to obtain its most basic materials (Ellen MacArthur Foundation, 2022b). This notion of protecting the integrity of a garment underpins the importance of **designing for circularity:** designers greatly influence the potential life cycle and lifetime of garments with their choices on materials, dyes, and production techniques. Designing for circularity could entail, for example, designing garments with greater seam allowances[1] to accommodate easier alteration and repairs. Children's clothing brand 'Petit Pli' designs clothes using origami techniques, such that the garment grows with the child - due to the pleats in the fabric, one single garment will fit a child from when they are just 4 months old, until they are 4 (Petit Pli, 2024).

A common misconception is that all natural textiles are good, and all synthetic fabrics are bad. However, it is not that black and white. Cotton is the most used natural fibre in the world, but also a 'thirsty' one, as it requires 10 to 20 thousand litres of water to produce 1 kg of clothing. And although most natural fibres do have a smaller carbon footprint than their synthetic counterparts, harvesting natural fibres leads to deforestation and often requires harmful pesticides for its cultivation (Unearthed, 2019). Lastly, many natural fibres are not suitable for the wear-and-tear of everyday life on their own. Fruit leathers contain at least 30% polyurethane, a plastic, to provide additional strength and durability (Oliver Co, 2023). This mix of natural and synthetic fibres is common - almost all clothing are made of a material blend, making them notoriously **hard to recycle.** Because of these blends, many natural fibres cannot complete their life cycle in the biological cycle, but end up in the technological cycle instead.

The notion that we should completely abolish synthetic fibres is also not the solution. In today's society, eliminating all synthetics from clothing is unthinkable. Firefighters, for example, heavily rely on synthetic, fire-resistant clothing to protect them on the job. In the medical world, many surgical textiles depend on the material properties of synthetic fibres (Textile Learner, 2021). As the Butterfly Diagram shows, the solution lies in creating a circular economy in which garments' life cycles are extended, or otherwise are resold, reused or refurbished as much as possible. And as a last resort, we should recycle garments and textiles that have truly reached their end of life (Ellen MacArthur Foundation, 2022b).

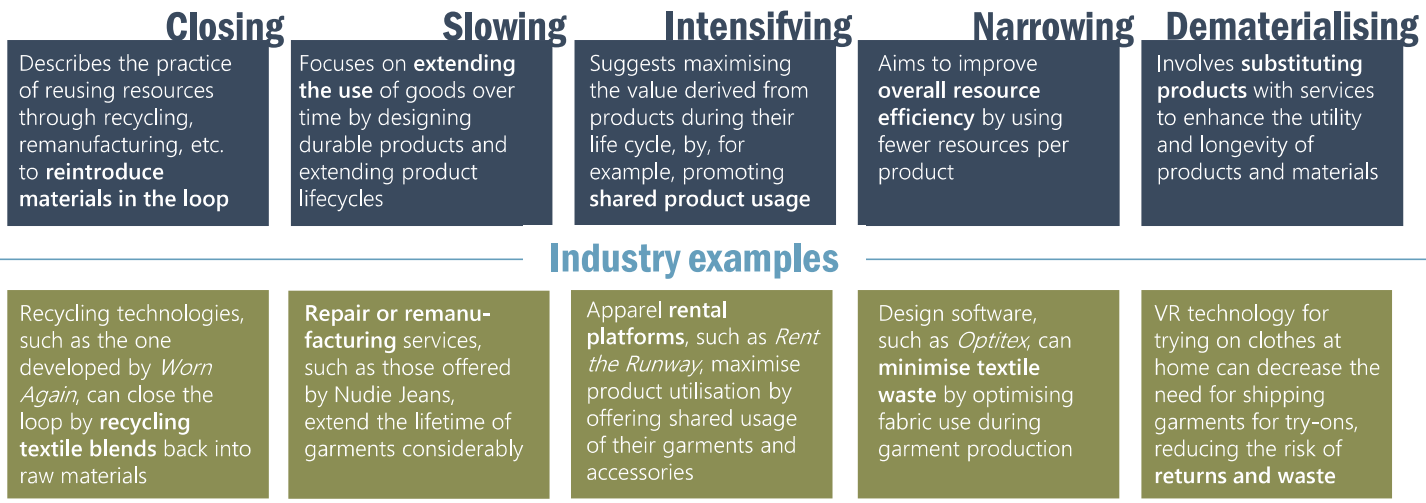
[1] A seam allowance is the distance from the raw edge of the fabric to the seam stitch line. It allows for the formation of all seams by providing excess fabric for efficiently stitching a seam together (Alexei, 2018).

2.2. Strategies for the Circular Economy

The Butterfly Diagram, as discussed in Section 2.1, helps to create an understanding of the different loops of a closed-loop CE, and is especially helpful in placing the different loops into context concerning value and supply chains (Ellen MacArthur Foundation, 2019; Geissdoerfer et al., 2018). However, it lacks in certain areas if we were to use it for CE strategy formulation. While the Butterfly focuses primarily on material flows, it does not provide us with much information on strategies that consider a range of actions outside direct material involvement. For example, other important aspects to consider are resource efficiency, product design, and consumer behaviour. Hence, in this Section, I explore various CE strategy frameworks, found in CE literature, and investigate CE strategies used in fashion industry research.

Although the exact definitions of the CE differ in the literature, the core principles are agreed on by many. It is the approaches, or strategies, towards a CE that are subject to a large degree of variety (James et al., 2019). Many different models and terminologies have been coined in the literature to describe CE strategies. Braungart et al. (2008) used the terms **cradle-to-grave** and the **cradle-to-cradle** (McDonough, 2002) flow of resources to show that resources either follow a linear or circular model. However, its high level of abstraction makes that firms find it difficult to implement (Balkenende & Bakker, 2018). Stahel (1981) used the terminology **closed-loop systems** rather than circular systems, and argued that there are two distinct loops within a closed-loop system: the reuse of goods and the recycling of materials. Balkenende and Bakker (2018) argue that the concept of closing loops formulates a more practical approach for businesses, as it recognises that closing loops as an organisation requires more than just addressing material flow, but requires adjustments to business models, logistics and financing.

Figure 2.2: Closing, slowing, intensifying, narrowing and dematerialising of resource loops explained. Accompanied by examples from the fashion industry (N. Bocken et al., 2016; Geissdoerfer et al., 2018; Haren et al., 2020).



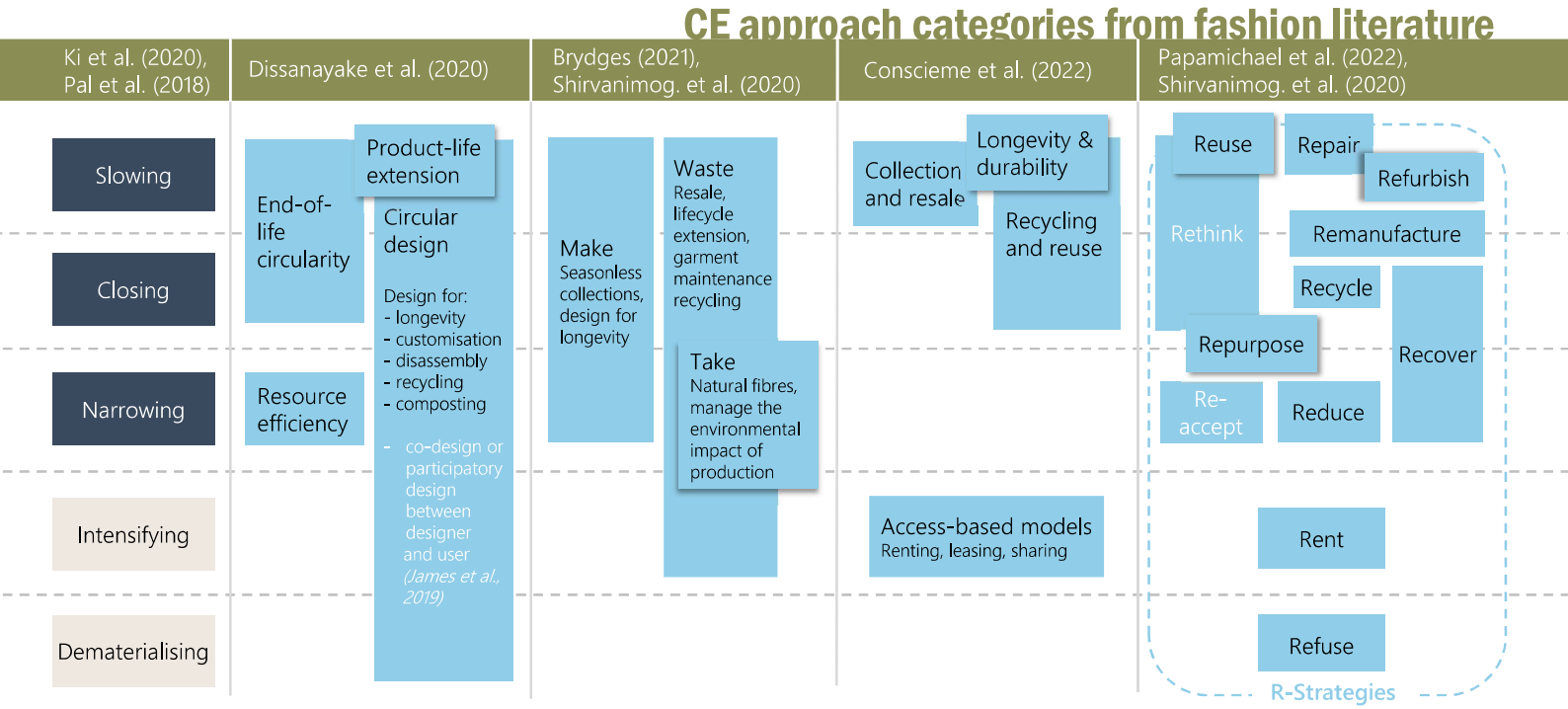
Based on the notions of Braungart et al. (2008) and Stahel (1981), N. Bocken et al. (2016) introduced three fundamental strategies to guide organisations to a CE: the **slowing, closing, and narrowing of resource loops.** Slowing refers to the life cycle extension of goods by repairing, maintaining or reusing them over time. Closing describes the efforts to keep materials in the economy by recycling or remanufacturing. Lastly, narrowing aims to improve the overall efficiency of the goods, by using fewer resources per product (N. Bocken et al., 2016; Geissdoerfer et al., 2018; Haren et al., 2020; Ki et al., 2020). Two years later, Geissdoerfer et al. (2018) added intensifying and dematerialising. **Intensifying resources** describes how we should maximise the value of each product by promoting pooled product usage, instead of individual ownership. **Dematerialising** describes how we should substitute physical goods for service of software solutions (Geissdoerfer et al., 2020; Haren et al., 2020). Figure 2.2 shows the CE strategies with examples from the fashion industry. Whatever CE strategy a firm pursues, N. Bocken et al. (2016) argue it is essential that circularity is taken into account in the **design stage** - this is especially relevant for fashion, since 80% of a garment's environmental impact is decided upon in the design stage (Ellen McArthur Foundation, 2022). The fashion industry presents more of these idiosyncrasies that require tailored CE strategies. Hence, I will review various CE strategies found within research on circularity within fashion.

2.2.1. Circular Strategies in Fashion

Within the body of literature on circularity in fashion, most researchers adhere to some sort of framework to categorise firms' individual strategies or textile waste management efforts according to their contribution to the CE (Balkenende & Bakker, 2018; Coscieme et al., 2022; Dissanayake & Weerasinghe, 2022; Ki et al., 2020; Papamichael et al., 2022). For clarity, consistency, and to link my work with the body of research on circularity in fashion, I wish to do the same. Within this Section, I provide an overview of the different kinds of CE strategies within the academic literature on circularity in the fashion industry, and synthesise the findings to formulate a CE strategy categorisation that fits my research.

Although there is significant overlap between the 'logic' behind CE strategies proposed for the fashion industry, there is little consistency in how these approaches are formulated and categorised. Brydges (2021), for example, proposes CE strategies categorised according to the life cycle stages she refers to as the 'take', 'make' and 'waste' phases. Dissanayake and Weerasinghe (2022) identified four key strategies that can accelerate the transition to circularity in fashion: resource efficiency, circular design, product-life extension and end-of-life circularity. Ki et al. (2020) and Pal and Gander (2018) categorise the practices using the concepts narrowing, slowing and closing, which is in line with the work of N. Bocken et al. (2016). Figure 2.3 shows an overview of CE strategy frameworks found in the literature.

Figure 2.3: An overview of categorisations of CE approaches used in the literature on circularity in fashion. The categories in white refer to categories specifically formulated to describe social/societal approaches.



As can be seen in Figure 2.3, a variety of categorisations of strategies exist. Many more undoubtedly exist, but I have attempted to show the models that vary significantly from each other - other categorisations in the literature lead to saturation as they were similar to the ones in the Figure. To construct Figure 2.3, I took the five CE strategies from Geissdoerfer et al. (2020) as a reference, as they are widely acknowledged both within and outside of CE research for the fashion industry. Then, I mapped four other CE strategy categorisations by placing their proposed categories in such a way that it shows which of the five strategies from Geissdoerfer et al. (2020) they are related to. Although I am using these five strategies as a reference, it is important to acknowledge that they do not describe the ultimate truth - as Pal and Gander (2018) remark, the three strategies of **narrowing, closing and slowing are not mutually exclusive.** When we consider individual efforts such as designing for circularity, overlap between these categories exists. However, by using them as a reference, I am attempting to show how various alternative CE strategy categorisations are not mutually exclusive either, and how some are not exhausting all CE approaches.

Figure 2.3 helps us draw conclusions on the CE strategy frameworks:

- Firstly, we see that the **occurrence of categories is skewed towards slowing, closing and narrowing.** Within the fashion industry, we see that the main individual strategies falling under intensifying are renting, leasing or sharing strategies. This makes sense, since maximising the value of a garment in the fashion industry without deteriorating its integrity requires the garment to be used as much as possible.
- As a reference category, **dematerialising shows almost no overlap** with other CE strategies. Refusing is the only category that I found relevant for dematerialising, as it entails avoiding the use of materials altogether. This aligns closely with the principle of dematerialisation by reducing material inputs or substituting apparel with services to minimise resource consumption. Substituting apparel for services might remind one of Hans Christiaan Andersen's *The Emperor's New Clothes*. However, VR technology, for example, allows consumers to virtually try on clothes at home instead of having them delivered and having to return garments that end up not fitting well.
- **Design for circularity** overlaps with every reference strategy, which could explain why it is such a significant topic within circular fashion. Dissanayake and Weerasinghe (2022) suggest designing for longevity, customisation, disassembly and recycling. Ninnimäki (2018) add to this by suggesting emotional design (slowing consumption through designing garments that foster a deep emotional connection) and design for transformation. Although I recognise the importance of considering CE strategies in the design stage, I argue that consolidating all efforts under a single CE strategy focused solely on design may be counterproductive.
    - Instead, a more effective approach would be to **consider design as an integral component within each primary CE category**. This approach compels firms and designers to holistically assess how their design choices contribute to broader CE objectives. By embedding circular design principles into each strategy, companies are pushed to address various aspects of sustainability, from prolonging product life cycles to minimising resource consumption.
- The categorisation of CE approaches based solely on the life cycle stage of materials or garments, as proposed by Brydges (2021) and partly by Coscieme et al. (2022), presents some limitations. Categorising CE approaches in this way may inadvertently sustain the misconception that a firm can achieve circularity by addressing circularity within its specific part of the garment's life cycle. This oversimplified perspective fails to account for the interconnectedness of the fashion ecosystem and the collective responsibility of all stakeholders in driving circularity, as underscored by Mentink (2014). For instance, a textile waste management firm may not see the immediate relevance of investing in circular approaches at the production (make) stage of the garment life cycle. However, I argue that this narrow focus **overlooks the potential synergies and opportunities** for collaboration across different life cycle stages. To conclude, I suggest that instead of taking the perspective of life cycle stages of a garment or material, we should take the perspective to view its entire life cycle, and critically asses which approaches are suitable to increase the garment's circularity.
- Finally, I want to note how Papamichael et al. (2022) formulate **12 R-strategies** to describe CE approaches for textile waste management. I very much value the R-strategies as they are specific, exhaustive and highly applicable to the fashion industry. However, all R-strategies describe singular actions a firm can undertake to contribute to a broader goal of the CE, hence I argue that they are better suited as sub-categories, or approaches, within a broader CE strategy category. This is in line with the framework used by Shirvanimoghaddam et al. (2020), who use slowing, closing and narrowing as their main categories, and the R-strategies as sub-categories.

To synthesise the above, I argue that it is best to adhere to a CE strategy framework that (1) is **relevant to the fashion industry,** (2) takes the **perspective of the entire life cycle** of garments or materials, as opposed to splitting the life cycle up in stages, and (3) contains **both overarching and specific strategies.** I argue that including slowing, closing and narrowing as main CE strategy categories accounts for point (2). Regarding the 12 R-strategies as sub-categories then accounts for point (3), and by excluding intensifying and dematerialising, we ensure the framework is optimally relevant for the fashion industry, hence answering to point (1).

A Critical Look at Resource Narrowing

So far, by analysing and comparing different CE strategy frameworks, I have drawn conclusions on what I believe to constitute to an effective framework. However, I want to address one aspect that I consider as a critique to the proposal I made above. Geissdoerfer et al. (2020) propose four generic CE strategies especially formulated for circular business models: cycling, extending, intensifying and dematerialising strategies. These strategies are very similar to the strategies proposed by the same researchers two years before - 'cycling' refers to the same principle as closing, and 'extending' refers to slowing. The category from the original list that is dropped is 'narrowing'. They argue that **narrowing should be excluded when considering CBM strategies,** since no BM is compliant with CE principles by solely narrowing resource loops. The latter implies an improvement in production efficiency, hence not being enough to justify a CBM on its own. Geissdoerfer et al. (2020) note it can be rather seen as an 'add-on' to CBMs.

I disagree with the notion of Geissdoerfer et al. (2020), as I argue that narrowing resource loops is essential to achieve circularity in the fashion industry. An exemplary case is Fairbrics, a company that has developed innovative technology to produce PET[2] from CO2, effectively narrowing resource loops in the fashion industry. By utilising CO2 as a feedstock, Fairbrics eliminate the need for fossil fuels in PET production, thereby significantly reducing resource consumption per garment (Fairbrics, 2023). While Geissdoerfer's exclusion of narrowing resources may have its merits in certain industries or contexts, examples like Fairbrics demonstrate the immediate benefits of resource efficiency in addressing pressing environmental concerns within the fashion industry. By narrowing resource usage, companies not only reduce their environmental footprint but also enhance their operational efficiency and resilience to resource scarcity. Therefore, I argue that **narrowing resources should be considered a fundamental aspect of CE strategies in the fashion industry.**

2.2.2. A Social and Societal Perspective on Circular Strategies

Describing circular approaches in fashion without acknowledging their social and societal implications would be like describing the wrap dress without mentioning Diane von Furstenberg. The fashion industry has a huge societal and social impact. In the positive sense, garments keep us warm in winter and cool in summer. Fashion allows us to express ourselves, feel connected to our community, keep traditions and cultures alive, and is a major source of employment. However, polluting chemicals and textile waste endanger our health, employees in manufacturing facilities are often not paid a living wage and work in unsafe conditions (Clean Clothes Campaign, 2022), and the unfair competition by large brands forces local enterprises out of business. But how is this all related to circularity, and **how does the literature account for social and societal actions within circular strategies?**

The role of social aspects remain under-prioritised in the conceptualisation of the CE (Beyer & Arnold, 2022). Even the widely-used 'take-make-waste' terminology leaves the user out of the equation (Palm et al., 2021). Paradoxically, the social and societal contributions to the implementation of circular fashion are paramount for its success: to reach end-of-life circularity, we must make responsible disposal of clothing a social norm. To enable garment sharing or trading models, society must move away from its current preference for ownership over its closet. Palm et al. (2021, p. 653) describe it accurately by arguing that *"different kinds of social actors have different capacities to change their own behaviour and that of the system as a whole"*. Following this line of reasoning, circular fashion can be seen as a **social-ecological system,** highlighting the interdependence of natural ecosystems and human society (Konietzko et al., 2023; Palm et al., 2021).

From the articles shown in Figure 2.3, most categories cannot be specifically attributed to social or societal strategies, but refer to material flow within the fashion value chain. The two R-strategies by Papamichael et al. (2022), **'rethink' and 're-accept'** (shown in white in Figure 2.3) directly address strategies that consumers, and society as a whole, need to adopt for moving towards a CE. Rethinking implies that consumers give explicit thought to what they buy and how they plan to dispose of it, while re-accepting describes how society must embrace and accept new materials and products, such as recycled or sustainable fabrics. Additionally, Shirvanimoghaddam et al. (2020) mentioned 'supporting sustainable products and local suppliers' as an example of a concrete action consumers can take under their 'rethink' strategy.

[2] Polyester fabrics are made from PET

Furthermore, I have included circular design strategies as formulated by James et al. (2019) under the design strategies from Dissanayake and Weerasinghe (2022). In James's paper, they suggest **design by participation and co-design** between designers and users increases social awareness and attachment towards garments, potentially increasing a garment's lifetime. Lastly, as a part of their approach towards creating a new mindset through circular strategies, Papamichael et al. (2022) suggest that to properly implement the R-strategies, the circular strategies must be supported by consumer education, promotion, knowledge exchange and motivation.

Based on the above, we clearly see a **two-way interaction between** social and societal aspects and circular fashion. On the one hand, social and societal norms and attitudes must shift regarding buying, using, maintaining and disposing of their garments. On the other hand, firms, governments and industry stakeholders are responsible for implementing circular strategies that impose no harm on local and global communities and promote social equity (Beyer & Arnold, 2022; Palm et al., 2021). Palm et al. (2021, p. 654) refer to this as **sustainable circularity**: *"Sustainable circularity not only closes material cycles but also responds strategically to complex intertwined social and ecological pressures..."*. I believe that, as the fashion industry has so many undeniable interactions with society, it would be a mistake not to consider social and societal aspects within circular strategies, innovations and plans. Hence, I account for social and societal within my definition for Circular Innovations, presented in Section 2.3.2.

2.3. An Introduction to Circular Innovation

In general, innovations can be described as the entrepreneur's tool through which they exploit opportunities to change businesses or services (Drucker, 1985). Edwards-Schachter (2018, p. 66) states that the nature of innovation is described by *"invention," "novelty,"* and *"change"*. In the 1960s, innovation was exclusively seen as a technology-based novelty, attributed almost solely to large firms and involved elaborate R&D processes and patenting activity (Martin, 2016). We have come a long way since then, and recognise that innovation is not exclusive to industry incumbents but can occur at any level within an economy, industry or region. Since the 1960s, we have expanded our typology such that product, process, organisational, and marketing innovations are also included. Edwards-Schachter (2018) remarks that the types of innovation mentioned in the literature are vastly expanding, as innovations can also be considered social, green, inclusive, grassroots, or lean, to name a few. Two terminologies of innovation that are relevant to my research are Circular Innovations (CIs) and Eco-Innovations (EIs), which I will present in this Section.

Innovations can either be incremental or radical. Incremental innovations describe gradual, continuous modifications that enhance -but don't change- a firm's existing processes and systems, whereas radical innovations are competence-destroying, discontinuous changes that upend the system (Carrillo-Hermosilla et al., 2010). A variety of scholars argue that to attain a CE, radical innovations for both circularity and sustainability must be made (Carrillo-Hermosilla et al., 2010; Kircherr et al., 2017). de Jesus and Mendonca (2018, p. 76) formulate the need for innovation in such a transition by noting that *"transition is an inherently innovation-intensive process of reconfiguration and adaptation"*.

2.3.1. Circular vs. Eco-Innovations

As much consensus as there is on the importance of radical innovations to transition towards a CE, as little there is consensus amongst scholars on the typology of circular-oriented innovations (Engelen, 2023). **Multiple terminologies exist** to classify innovations within the realm of sustainability and circularity: 'green-', 'sustainable-', or 'eco-' innovations have all been coined in the literature (Hermann & Wigger, 2017; Schiederig et al., 2015). Hermann and Wigger (2017) argue that sustainable innovation incorporates a social domain to innovation, while the others are more geared to being environmentally friendly. Out of them, **Eco-Innovation (EI)** is the only one that draws a link between innovation and the principles of the CE (Schiederig et al., 2015). Carrillo-Hermosilla et al. (2010) point out that although many definitions have been given to EIs, they remain very general, leading to many kinds of innovations being defined as such. Important elements of EI are its positive environmental impact and its novelty, and are defined as *"an innovation that improves environmental performance"* (Carrillo-Hermosilla et al., 2010, p. 1075). This definition is taken a step further by de Jesus and Mendonca (2018), who argue that EIs are not merely a green technology, but an innovation that acts as a catalyst for change, enabling a shift away from the current state towards the establishment of a socioeconomic system founded on the principles of the CE.

The term CI is relatively new in CE literature, and upon review I found that it is used at different levels of abstraction. For example, Guzzo et al. (2019) present a CI framework, which is not focused on one standalone novelty, but views CI from a conceptual, strategic and practical perspective. Others have defined CIs as being singular innovations. In his thesis, Engelen (2023, p. 36) provides a definition of a CI by combining elements of the definitions of the CE and EIs:

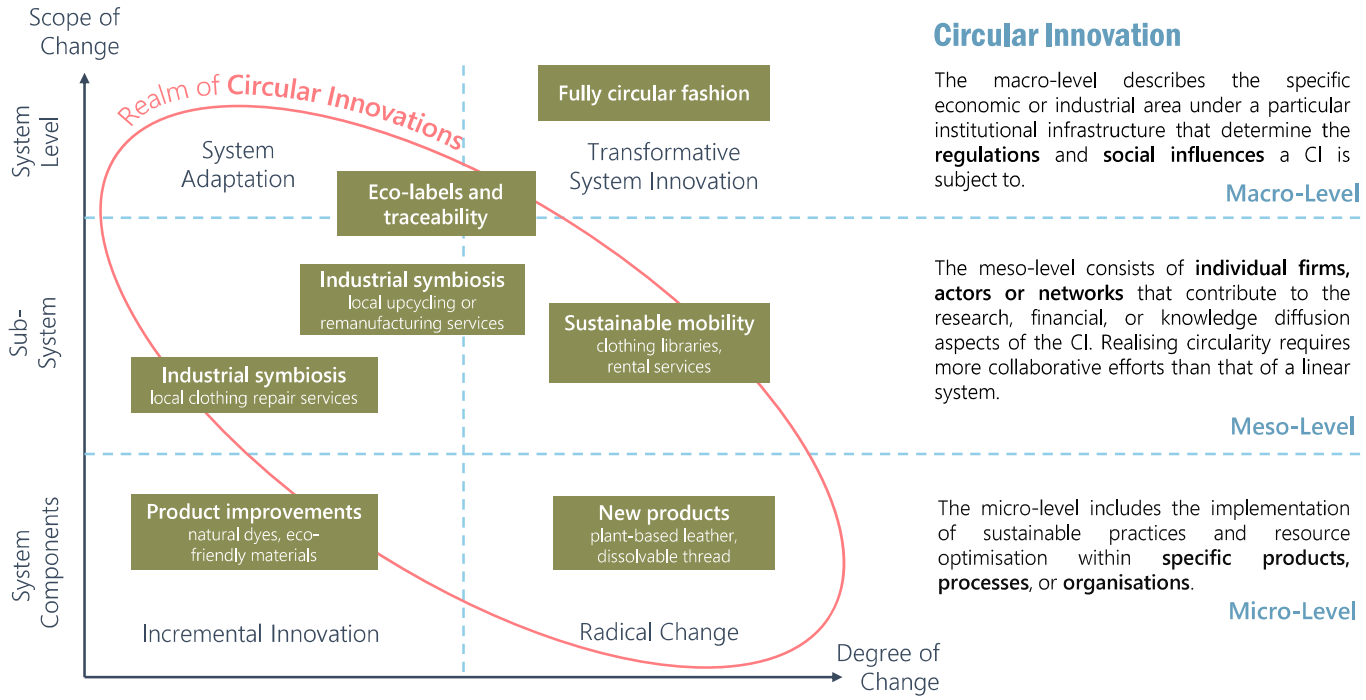
> "A **circular innovation** is a novelty that, by design, is **resource-efficient** throughout its life cycle, has a positive economic impact, and results in **reduced environmental impact,** regardless of whether the latter is intentional. This impact can be achieved through reduced resource input, waste, emission, and energy leakages and by replacing the end-of-life concept enabled by unique business models that, through refusing, reducing, reusing, repairing, remanufacturing, recycling, or recovering materials, capitalize on **closing, slowing, narrowing, intensifying, or dematerializing resource loops**"

Engelen (2023) notes that categorising a technology or product as a CI might be insufficiently justified due to the **reduced inability of a single technology or product to be fully circular**. Its circularity depends on how the product is produced, used, and what happens at it's end-of-life. The latter might explain why many publications refer to technological innovations as 'enablers' to CBMs or the CE as a whole (Dissanayake & Weerasinghe, 2022; Todeschini et al., 2017). However, I believe it is crucial to recognise that if an innovation plays a pivotal role in advancing circularity, it warrants classification as a CI. This perspective aligns with the fundamental goal of the CE, which is to transition towards sustainable resource use and minimise waste. Therefore, labelling such innovations as circular serves to underscore their critical role in driving the transformation towards circular business practices and sustainable economic systems.

Circular Innovations: the Bigger Picture

Engelen (2023) explains how CIs exist on micro, meso, and macro-levels. Based on these levels, Figure 2.4 shows the 'realm' of CIs within the classification of EIs (the circle within Figure 2.4 being Engelen's contribution), the classification of which is developed by the European Commission (2013). My contribution to Figure 2.4 are the fashion industry-specific examples. The original figure means to display the classification of EIs based on their degree of change (radical vs. incremental) together with their scope of change, i.e. what system dimensions the innovation impacts. Mapping the realm of CIs within this figure underpins the difference between EIs and CIs: within the EI realm, **CIs occupy a distinct space that addresses a narrower scope compared to EIs,** which encompass systemic changes.

Figure 2.4: The classifications of EIs, containing a contextualisation for CIs.



European Commission (2013) identified six types of EI: product, process, organisational, marketing, social and system innovations. The latter describes a series of connected innovations resulting in a systems-scale change that reduces environmental impact. CI, in comparison, only describes a single technological product or process innovation that contributes to slowing, narrowing, closing, dematerialising or intensifying resource loops and hence addresses a more specific category of innovation. The European Commission (2013) do criticise that focusing on individual technologies or products undermines the efforts needed to pursue **system-level change**, as it does not take into account how the innovation relates to other players in the system. I argue that studying individual CIs does not exclude the consideration of their context within a wider system (or industry), but instead allows for a more in-depth analysis on how that specific innovation could be introduced into the system, potentially inducing system-level change. In Section 5.3, I further elaborate on why I take a systems' perspective to study CIs within this research.

CIs are placed within the pink circle: the upper right quadrant of Figure 2.4 is out of scope for a single CI - radical technological change to an entire system goes beyond innovations to specific products or processes, but such a shift in techno-economic paradigm requires the harnessing of institutional and social dimensions as well (Carrillo-Hermosilla et al., 2010). To place this in the context of the fashion industry, we see that there is **no single CI that will upend the entire industry** - transforming the fashion industry to a fully circular one requires multiple technological breakthroughs, laws and regulations, and the social awareness amongst consumers. Within my research, I choose to work with the CI as opposed to EI, as well as building off of the CI definition as provided by Engelen (2023), for the following reasons:

1. The literature on innovations geared toward circularity within the fashion industry is largely focused on innovations to firms' business models. I want to focus on the innovations that help us bridge the technological gaps the industry faces in its transition to circularity. Engelen's definition allows me to **delineate these technologically oriented innovations from broader BMIs.**
2. EI is widely used in the literature, but has been given many definitions that all slightly differ. If I were to use EI within my research, I would have to formulate yet another description of what exact kind of EI I wish to focus on, which would only **'muddy the waters' more.** The relative novelty of the term 'circular innovation' also means that there is **less existing ambiguity** surrounding its definition, making it a clearer concept for my research.

In Section 2.3.2 I delve into what CIs in fashion exactly entail, and I propose a simple framework that helps categorise CIs within the fashion industry based on the synthesis I did on CE approaches in Section 2.2.

2.3.2. A Circular Innovation Framework for Fashion

In Section 2.1, I delved into the Butterfly Diagram from the Ellen MacArthur Foundation. Although this is a widely used and acknowledged framework for defining different levels (loops) of circular approaches in fashion, I argue it is not the best framework to categorise CIs in fashion. The number of frameworks to classify circular approaches, strategies and BMIs is growing rapidly - Figure 2.3 shows just a handful of them. While they do show overlap, they differ noticeably. An argument I used before is that I don't want to make yet another framework to further 'muddy the waters' - however, I do want to construct a **framework to classify CIs** for the following reasons:

1. For consistency and clarity throughout the research.
2. To be able to distinguish different kinds of CIs from one another, and have the categorisation provide meaningful information on the innovation's contribution to the CE.
3. To contribute to the literature on CIs within the fashion industry, and the link between CIs, CBMs and CBMIs. Geissdoerfer et al. (2020) have categorised CBM strategies based on earlier work of N. Bocken et al. (2016) and Geissdoerfer et al. (2018) - providing a categorisation of CIs that complements their categorisation of the CBMs will **anchor my research within existing literature.**
4. To be able to structure my multiple-case study. Categorising CIs enables me to **select representative cases** within my case study, as I will be able to group and distinguish start-ups based on which CI they have developed.

In the following subsections, I will first provide a nuanced definition of CIs to reflect the context of the fashion industry. I argue that the latter is necessary, as CIs in fashion will need to reflect the objectives of circular fashion to be considered circular. Thereafter, I will present the framework for CIs in fashion.

Circular Innovation: Defined for Fashion

Before constructing a framework for CI in fashion, we must revisit the definition of a CI to ensure it optimally describes CI in the fashion industry. Earlier in this Chapter, I touched upon the term 'circular fashion' and the concept of the fashion industry representing a social-ecological system. To tailor the definition of CI to reflect the latter, I have set out to formulate a definition of CIs in fashion, taking the definition of Engelen (2023, p. 36) and the definition of circular fashion by Rathinamoorthy (2019, p. 23) as a starting point.

Circular Fashion

A circular garment must be *designed for (1)* prolonged existence, *resource effectiveness (1),* nontoxicity, biodegradability, reprocessing and reusability, and with good morals in mind. The *total life cycle (2)* of the product should be *eco-friendly (3)* and should contribute to the *positive well-being of humans, the ecosystem, and society (3).*

A circular garment should be procured and produced with preferences given to local resources that should be biodegradable, *nontoxic (3),* and recyclable. Furthermore, the manufacturing and sourcing process should be *efficient (4),* ethical, and safe.

A circular garment must be *redesigned or altered (6)* into a different product to give it a *new application (5).* The components of the garment should be *recycled and reused (7)* for the production of a new item. If the product is unfit for recycling, the material should *be composted to become nutrients for plants and other living organisms in the ecosystem (8).* The products *should be used for as long as possible (9)* through *good maintenance, care, repair, and renovation (10). Sharing of the product (11)* with multiple users over the lifespan of the product is encouraged

Circular Innovation in Fashion

A circular innovation is a novelty that, *by design, is resource-efficient (1) throughout its lifecycle (2),* has a positive economic and societal impact and results in *reduced environmental impact (3)* by facilitating traceable, long-lasting, non-toxic, reusable, customisable, durable or biodegradable garments or processes.

Circular innovations contribute to *the replacement of the end-of-life concept* through socially sustainable processes, implying they're safe, ethical, and contribute to social equity.

They are enabled by unique business models that, through refusing, reducing, *repairing (10), remanufacturing (6), reusing, recycling (7),* or recovering resources, capitalise on *closing (8), slowing (9,10,11), or narrowing (4)* resource loops.

The text above shows how the two definitions are highly similar to begin with: the text in blue represents elements from the definition of circular fashion that I have included in the definition of CI in fashion. The text in pink represents elements I have added on top of both definitions. The numbered text in italics shows the elements that occur in both definitions. Both touch upon the notions of designing for circularity, positive environmental impacts, waste minimisation and CE strategies. However, there were three accounts where I felt an addition was necessary to reflect the idiosyncrasies of CIs in the fashion industry:

1 As I write in Subsection 2.2.2, the fashion industry forms a social-ecological system in which humans and nature are intertwined. The fashion industry is widely criticised for **neglecting its social and societal impacts.** The Rana Plaza disaster in Bangladesh, 2013, caused uproar in within the fashion industry, when after multiple whistleblowers voiced their concerns about the faulty state of the clothing factory, it collapsed and more than 1100 people tragically died (International Labour Organisation, 2023). For an innovation to contribute to circularity, I believe the innovation in itself should have a positive societal impact and be **socially sustainable.** Social sustainability is defined by Roca-Puig (2019, p. 917) as *"a quality of a human system based on a series of values or essential ethical principles (e.g., fairness, trust, equity, justice, cooperation, engagement) that foster lasting conditions for human well-being, particularly for the most vulnerable individuals or groups".*

   Although highly overlapping with the definition of circular fashion, **Engelen's definition fails to incorporate any social or societal aspects of CI.** Rathinamoorthy mentions that circular garments must be produced ethically and safely. I argue that more depth is needed in the definition to fully reflect the extent of the societal contributions of the fashion industry. Hence, I included 'societal impact' in the CI definition. Lastly, I added that CIs must consist of 'socially sustainable processes, implying they're safe, ethical, and contribute to social equity', based on the definition by Roca-Ruig.

2 Transparency and traceability are huge topics within the fashion industry: not only does traceability facilitate accurate environmental impact measurements, but also hold brands accountable for the working conditions of employees further up the supply chain. Hence, I have added that CIs must facilitate **traceable** garments of processes.

3 I have added fashion-specific granularity to Engelen's definition by highlighting that garments, services or other solutions in fashion should promote **longevity, non-toxicity, biodegradability, processability and reusability** from the design stage. As I have mentioned before, 80% of a garments' environmental impact is decided upon in the design stage. Therefore, including these aspects in the fashion CI definition is imperative to emphasise the importance of considering them in the design stage. Even if the CI itself does not concern the creation of a garment or textile, innovative processes should be non-toxic[3] and facilitate the implementation of the aforementioned elements in the manufacturing process they contribute to.

The Framework

Table 2.1 presents a **framework for the classification of CIs,** constructed to reflect CIs within the fashion industry. For each high-level strategy (closing, slowing, narrowing), specific approaches are listed that are relevant to the fashion industry. This Figure can be seen as an extension of the work of Pal and Gander (2018): within the narrowing, slowing and closing strategies, they created fashion industry-specific categories of methods used to move towards more sustainable business models (SBMs). My work presents a similar approach. However, my categories are specifically formulated to categorise CIs, whereas in the work of Pal and Gander (2018), CBMs and CIs are both suggested as methods for attaining SBMs.

Table 2.1: A tentative framework for the categorisation of CIs, combining the main approaches from N. Bocken et al. (2016) sub-categories synthesised from CE literature on fashion.

Circular Innovation		
Strategy	**Approach**	**Example Innovation**
Closing	Recycle	RFID technology for traceability or other clothing sorting technologies
	Re-manufacture	Tersus (2020) has invented a technology utilising recycled LCO2 to refurbish garments by a thorough cleaning process
	Design for disassembly or composting	Heat dissolvable thread by Resortecs (2023) or compostable waterproof garments by DIMPORA (2020) made out of miner-based membranes
	Tracking & Tracing	Dutch Tex.Tracer (2024) developed a traceability platform that gives brands insight into their products' journey and footprint along the entire supply chain
Slowing	Repair or maintain	BioRestore's laundry powder contains enzymes that remove lint and pilling and realign the garment's fibres to maintain its quality (BioRestore, 2020)
	Reuse	Thred Up (2023) developed an algorithm that streamlines the resale of secondhand clothing by assessing the condition and value of pre-owned garments
	Design for longevity or customisation	Evrnu (2023) created Nucycl® lyocell fiber, created from textile waste, and is designed to be durable and recyclable at the garment's end of life
Narrowing	Reduce	Colorfix (2023) minimises the environmental impact of industrial dyeing by reducing toxic chemical dyes and replacing them with DNA sequenced natural ones
	Recover	Finnish IonCell (2022) developed a technology to sustainably turn used textiles and old newspapers into new textile fibres
	Design for resource-efficiency	Dutch startup NEFFA (2024) developed a seamless manufacturing techn. using compostable biomaterials

To emphasise its relevance to the fashion industry, I have provided **industry-specific examples** within each proposed category. This framework follows from the conclusion I had drawn on CE approaches within Section 2.2 - to remain relevant for fashion, I have narrowed down the high-level strategies to closing, slowing and narrowing. Additionally, I made sure to follow up on my own advice of including 'design for circularity' within each high-level category, tailored to be relevant to the respective category. Lastly, I assessed which of the 12 R-strategies by Papamichael et al. (2022) were relevant to fashion CIs. Here, I chose to leave out highly similar strategies to maintain **parsimony** in my framework.

[3] Many processes within the fashion industry, for example textile dying, make use of toxic chemicals

2.4. Circular Innovation and Circular Business Models

As stated before, 'Circular Innovation' is a relatively new term in the body of literature on the CE. To properly understand its meaning within the context of related concepts, such as Circular Business Models (CBMs) and Circular Business Model Innovations (CBMIs), I take a top-down approach. I will start with a high-level, broad overview of the literature on the most common form of innovation to be found in the literature on fashion - business model innovations (BMIs). Then, I explain the differences between CIs and BMIs and show how they are related. Lastly, I propose an adaption to the widely acknowledged framework of Geissdoerfer et al. (2018) that synthesised CIs, CBMs and CBMIs.

2.4.1. Business Models: What You Need to Know

The literature on the transition to a more circular fashion industry contains a vast amount of studies on the transition to more circular BMs through BMI. Upon reviewing the literature on technological- and business model innovations towards the CE, I found that the terms are used interchangeably, or that they are not properly distinguished. For example, Ostermann et al. (2019) conducted a multiple-case study on BMIs for the CE within the fashion industry but stated in their final remarks that "it was possible to identify different types of BMI guiding the pathway to implementing circularity in the industry, by means of services and products. Innovation and technology were identified in all cases". This example shows that in some cases, **the distinction between technological innovations and BMIs are not clearly articulated,** leading to ambiguity in understanding their respective contributions to achieving circularity. Markides (2006) agrees that the similarities between technological innovation and BMIs lead to some researchers treating them as the same, which is a mistake. In this Section, I set out to briefly explain BMs, what makes them circular, and what accounts for a circular business model innovation (CBMI). With that understanding, I can then outline the differences between a CI and a CBMI, and show the interplay between the concepts.

Business Models and Business Model Innovations

BMs can be seen as a firm's *"structural template of how [they] run and develop their business"* (Clauß, 2017, p. 3). It addresses a firm's ability to identify target users and customer groups, define a mechanism for revenue generation, estimate a cost structure, and formulate a competitive strategy (Baden-Fuller & Mangematin, 2012; Chesbrough, 2010). Although multiple typologies exist, the literature often refers to BM typology as consisting of three dimensions: **value creation, value proposition and value capturing**. Value creation describes how a firm's resources and capabilities create value (Clauß, 2017), whereas the value proposition, as described in the Introduction, outlines the advantages that customers can anticipate from a products or service (Osterwalder et al., 2015). The value capture then outlines how a firm's value proposition is converted into revenue (Clauß, 2017). BMIs are innovations to a firm's value proposition, value creation, and capturing of value (Baden-Fuller & Haefliger, 2013; Clauß, 2017). As I stated before, I found upon review that technological innovations were often considered under BMIs. It is true that the product or process that a firm offers, so also its technology, falls under the term 'value proposition', which is visualised in the Business Model Canvas, for example (Osterwalder & Pigneur, 2010). Chesbrough (2010) offers a neat explanation of the nuanced difference: the value proposition is the value which is created for customers by an offering *based* on a technology.

Circular Business Models and Circular Business Model Innovations

Now an understanding is created on the difference between CIs and a BMIs, we can venture into the domain of CBMs and CBMIs. Geissdoerfer et al. (2018, p. 713, 714) present Sustainable and Circular BMs (SBMs/CBMs) as an extension of the traditional BM. Mentink (2014, p. 24) provides a succinct, but clear definition: *"a circular business model is the rationale of how an organisation creates, delivers and captures value with and within closed material loops"*. By deploying CBMIs that facilitate slowing, closing, narrowing, intensifying or dematerialising resource loops, a firm can transition its SBM into a CBM (Geissdoerfer et al., 2018). (Geissdoerfer et al., 2020) follow the line of reasoning that CBMIs are related to BMIs such as CBMs are related to BMs. The terms CBM and CBMI have received critique from some scholars - other than stating a lack of consistency between their definitions, they argue that absolute CBMs or CBMIs do not exist. According to them, it is unrealistic to obtain a complete CBM within a single firm, as **no single party can be fully circular** - it requires a larger network to close the loop (Mentink, 2014). Brydges and Pugh (2021) even argues that full circularity is not currently attainable for the fashion industry, but that by taking steps towards circularity the industry can grow its acceptance and approaches in favour of the CE.

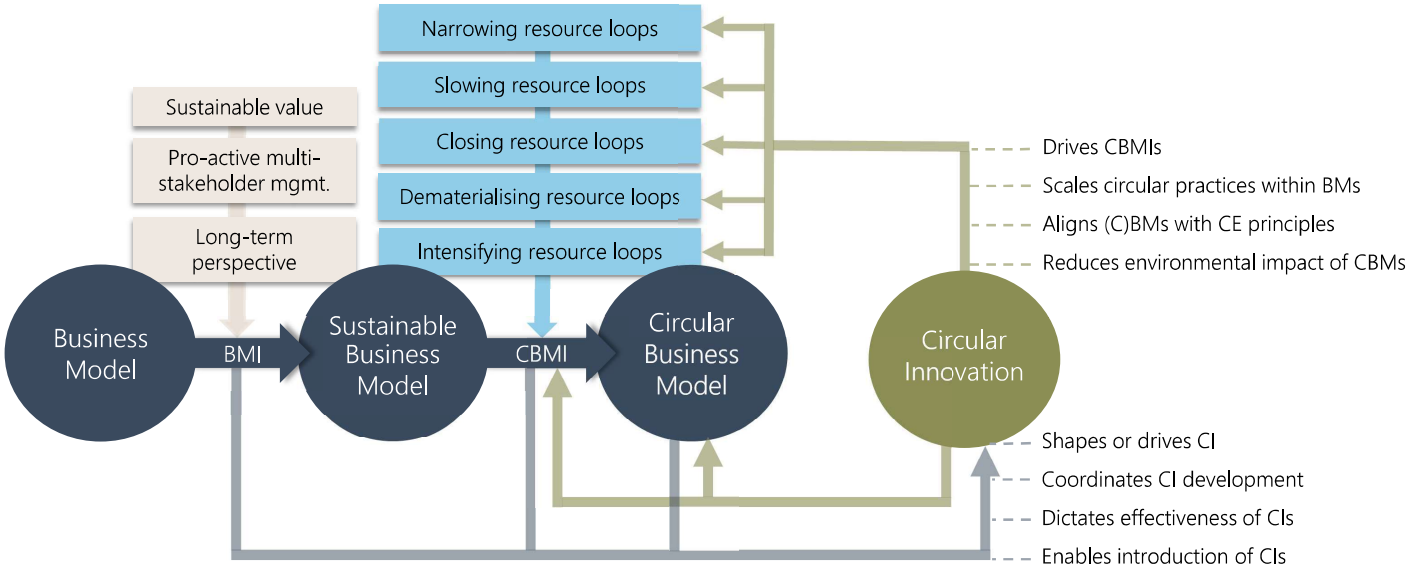
To overcome the conceptual limitations that the term 'CBMI' poses, some scholars propose that instead of being fully circular, BMIs rather contribute to introducing circular practices in BMs. Pieroni et al. (2019) introduces the concept of **business model innovations for the CE, or BMI4CEs.** I do acknowledge that fully circular CBM(I)s are difficult to attain due to an unavoidable interdependence of multiple players within an industry to become circular. However, I choose to continue using the definitions CBM and CBMI for two reasons. Firstly, doing so allows for a clear explanation of the role of CI within CBMs and CBMIs (see Subsection 2.4.2). Secondly, it allows for a clear understanding and discussion of the role of BMs and BMIs in advancing CE principles within the fashion industry.

2.4.2. A Synthesis on CIs, CBMs and CBMIs

Up until now, I have elaborated on BMs, BMIs, their circular counterparts, and how they relate to each other. What is left, is to synthesise the latter with the concept of CI. **CIs, CBMs and CBMIs are closely related.** Although Engelen (2023) provided some insights into the relationship between CIs and CBMs (see Table 2.2), I want to further this direction of review by providing a synthesis of the concepts. As a first step in my synthesis, an exert from Geissdoerfer et al. (2020, p. 8) is important, who argue that *"the [CBMI] concept is related to the [BMI] concept in the same way as [CBMs] are related to [BMs]".* Extrapolating this logic to include CIs within their framework, would allow me to state that **the CI concept is related to the innovation concept in the same way that the circular business model innovation concept is related to the business model concept.** Again, following the argumentation of Geissdoerfer et al. (2020), the latter allows me to tap into existing, acknowledged linkages of innovations to BMIs to explain the relationship between CIs and CBMIs.

Partaking in circular activities can upend traditional ways of operation, and CBMIs describe the ways firms adopt to capture value using new circular technologies or ideas (Ostermann et al., 2021; Teece, 2010). An example of this is the invention of the infinitely recyclable tennis shirts by the Spanish 'Infinite Athletic'. Using discarded tennis racket strings, this company re-manufactures the strings into yarn, with which they can produce shirts (Infinite Athletic, 2023). This technology can be classified as CI, but also requires a BM change - for the shirts to be recycled, reverse logistics must be in place for customers to return their shirt. The latter describes a **need for a BMI to support the CI.** One cannot go out with the other - to identify how CIs impact CBMIs and CBMs, and vice-versa, I reviewed literature that addresses the relationship between technological innovations and CBM(I)s - an overview can be seen in Table 2.2. Using Table 2.2, Figure 2.5 was constructed. It visualises the relationship between CIs, CBMs and CBMIs, adapted from the work of Geissdoerfer et al. (2018). To the work of Geissdoerfer (dark blue circles in Figure 2.5), I added the concept of CI (green circle), and visualised the relationships between CIs, CBMs and CBMIs with arrows.

Figure 2.5: A schematic overview the synthesis of BMs, BMIs, and CIs adapted from Geissdoerfer et al. (2018). The left part of taken from Geissdoerfer, and the concept of CI, together with the relationships between CBMIs, CBMs and CIs is my contribution.



On the left-hand side of Figure 2.5, you can see how BMIs can enhance a transition from traditional BMs to CBMs. The right-hand side visualises the synthesis between CBMs, CBMIs and CIs. It must be noted that all inter-dependencies listed in Table 2.2 can form drivers or barriers when the CI or CBMI is succeeding or lacking, respectively. For example, Eisenreich et al. (2021) identified that a strong focus on linear BMs can hinder the adoptions of CIs. In other words, the positive effects/symbioses listed in Table 2.2 can mirror barriers, with reverse effects. An interesting follow-up question, but out of scope for this research, would be to identify which exact elements of the BM are susceptible to innovation when CIs are adopted - Todeschini et al. (2017) evaluated trends and drivers of sustainability-related BMI for firms in fashion, and found that technological innovation mainly drives innovation regarding key resources, key activities and cost structures within a firm's BM.

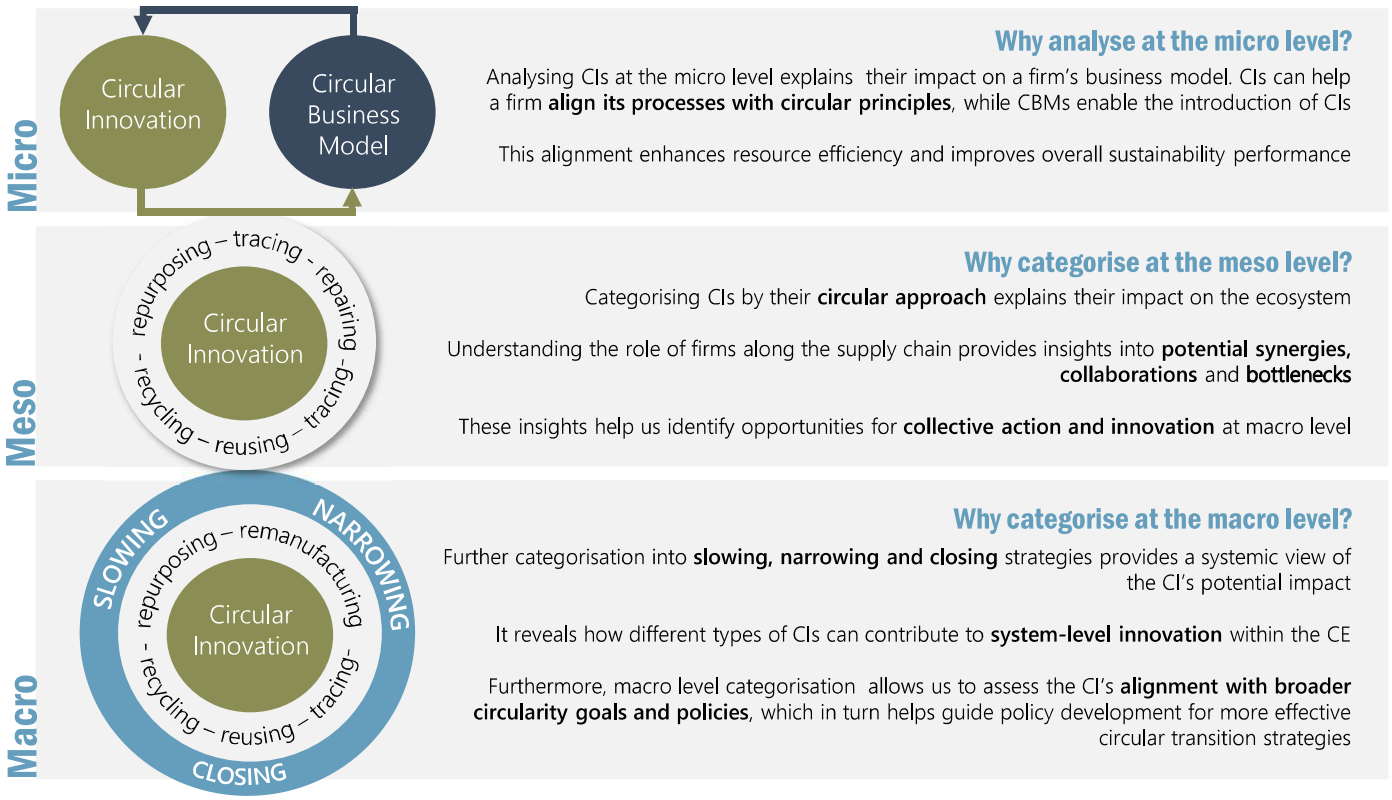
Table 2.2: Exerts from the literature that describe the relationship between CIs and CBMs and CBMIs. The top half of the table describes the dependence of CBMs on CIs, while the bottom half describes the dependence of CIs on CBMS.

Relationship	Justification	Source
CIs can drive (circular) BMIs	"...technological changes and societal trends such as "dematerialization", "decoupling" or "circular economy" suggest that companies must implement innovative, sustainable business models in order to capture value in an otherwise competitive environment"	Hermann and Wigger (2017, p. 3)
	"Technological advancements into, for example, more robust recycling technologies can act as enablers for further adoption of [BMIs] as they can increase the incentive for fashion companies to retain ownership of their garments with novel business models"	R. Salmi (2021, p. 41)
CIs can scale circular practices in BMs	"Environmental value in SBMs based on circular resource loop practices is not fully realized due to technological limitations hindering scalability potential"	Pal and Gander (2018, p.259)
	"Several barriers such as technological limitations, institutional inertia and dynamic customer preferences restrict scalability of [CBMs]"	Pal et al. (2019, p. 299)
CIs can align BMs with CE principles	"Through several disruptive innovations related to products and materials, such as use of recycled fibres,... the industry as a whole has strived towards being more restorative and regenerative in the flow of not only products, but also by-products and wastes by narrowing, slowing and closing the resource and energy flows"	Pal et al. (2019, p. 298)
	"Emerging technologies, especially digital ones, enable the alignment of different CE principles in BMI4CE"	Ostermann et al. (2021, p. 8)
CIs can reduce the environmental impact of CBMs	"Circular business models come with a new set of technology requirements. Innovation in technology to minimize the negative impacts of the production process is required to reduce resource consumption.	Dissanayake and Weerasinghe (2022, p. 39)
(C)BMIs can help coordinate CI development	" Innovating the [BM] can help coordinate technological and organisational innovations that involve stakeholders within the value network"	Nußholz (2018, p. 187)
CBMs can shape or drive CIs	"... [CBMs] ... explain how an established firm uses innovations to create, deliver, and capture value through the implementation of CE principles"	Lahti et al. (2018, p. 3)
	"Business models are not just statements of economic linkages but also cognitive devices; business models held in the minds of these actors influence technological outcomes"	Baden-Fuller and Haefliger (2013, p. 423)
CBMs dictate the effectiveness of CIs	"The effectiveness of circular strategies impact the effectiveness of circular innovations to maximize and recapture value"	Engelen (2023, p. 34)
	"[CBMs] facilitate a product/process to become circular because they facilitate the resources and complementary services required to maximize resource utilization and value recapture"	Engelen (2023, p. 35)
CBMs enable introduction of CIs	"Technology innovations in fashion require business model innovation to be successful"	Pal and Gander (2018, highlights)

A Triple-Layer Framework on Circular Innovation

Up until now, I have defined CIs in fashion and categorised CIs based on their contribution to the CE. What remains, is to link CIs to the broader circularity perspective, i.e., how CIs are involved in circularity within fashion across the micro, meso, and macro level. Lanaras-Mamounis et al. (2022) argue that although there are many frameworks that evaluate CE strategies, most of them avoid examining multiple levels of analysis. By examining the CIs within firms and also along supply chains, we gain insights into potential synergies and bottlenecks in its utilisation and diffusion. This understanding enables us to identify opportunities for collective action and resource optimisation at the macro level. The other way around, we must realise that all the ecosystem of firms at the meso level and regulations and trends at the macro level influence what kind of CIs are developed and how they are introduced. To summarise, **understanding the context surrounding CIs** is crucial for assessing their impact and potential for system-level transformation.

Figure 2.6: A synthesis of CIs, CBMs, and the three levels of analysis, along with an explanation on the importance of analysing CIs on the micro, meso and macro level.



The framework's notion is legitimised by Lanaras-Mamounis et al. (2022), who developed a triple-layer framework evaluating firm involvement within the CE, divided into the micro, meso and macro levels. My framework is an adaptation of this, as I don't assess the involvement of a firm within the CE, but of a CI. They argue that the micro level refers to strategic actions taken by a single firm. Here, the micro level describes how a CI impacts a firm's processes and BM. According to Lanaras-Mamounis et al. (2022, p. 112), the meso level refers to *"material/energy/waste/equipment exchanges between different firms".* This links seamlessly to my framework, since the strategies of recycling, reusing etc. require firms to exchange textile waste or feedstock, for example. Lastly, the macro level includes the overarching CE strategies, such as 'reduction in total amount of raw materials used', which can be achieved by recycling and reducing at meso level. An **example** to illustrate the framework's utility: Recyc'ELIT's CI encompasses a technology that enables the recycling of complex polyester textile blends. On the micro-level, the CI influences how Recyc'ELIT operates, how they earn money, what people they need to hire, etc. On the meso-level, the CI enables the recycling of garments containing polyester. Recyc'ELIT are dependent on brands, retailers, textile sorting and transportation companies to deliver them the feedstock. The widespread adoption Recyc'ELITs CI shows the CI's potential impact on the macro-level: to close plastic resource loops.

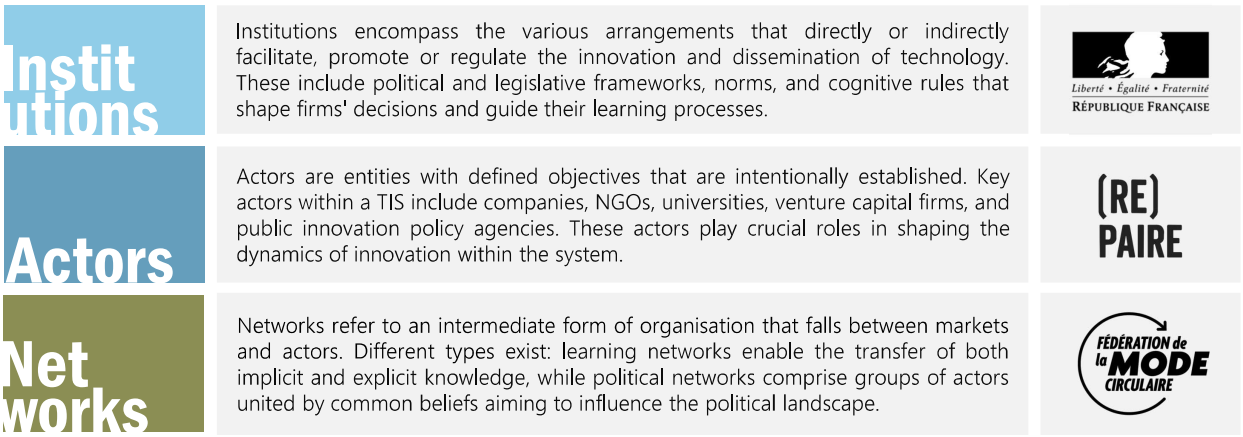
2.5. Theoretical Framework

Up until know, I have delved into the meaning of circularity in fashion and argued for the relevance of CIs within circular strategies. What remains, is to outline the theoretical framework that will guide my analytical approach. As my Introduction have given away, the theoretical perspective for my research is the **Technological Innovation System (TIS)**. In this Section, I will elaborate on what a TIS entails, along with the TIS functional approach. Lastly, I will consider a number of alternative approaches acknowledged in the literature to study innovations, and argue why the TIS is most fitting.

2.5.1. The Technological Innovation System

To understand what a TIS entails, we must take a step back and understand what an **innovation system** is. An innovation system attempts to analyse how all firms, organisations, institutions, and other actors contribute to the emergence of an innovation (Edquist, 2001; Hekkert et al., 2007). One of the most important notions of an innovation system is that firms don't innovate in isolation, but instead, it must be seen as an evolutionary and collaborative effort (Edquist, 2001). An innovation system can be described as a whole that can be delineated, consisting of two entities: components, and the relationships between them. In general, there are three types of components, which are described in Figure 2.7.

Figure 2.7: The three components of a TIS explained (Bergek, Hekkert, & Jacobsson, 2008; Edquist, 2001). Examples relevant to the French fashion industry are shown on the right-hand side.



Over time, many innovation system approaches have been formulated, taking **national, regional, sectoral, or technical boundaries** of the system (Bergek, 2001; Planko et al., 2017). The innovation system considering technical boundaries, or the TIS, is a widely acknowledged and utilised approach amongst scholars in analysing the dynamics of the development, utilisation and diffusion of technological innovations (Jansma et al., 2018). In the late 1980s, a group of Swedish scholars developed the first notion of a TIS based on the earlier concept of a technological system, to establish a stronger groundwork for innovation policy (Bergek, 2019; Carlsson & Stankiewicz, 1991). Carlsson and Stankiewicz (1991, p. 49) define a TIS as

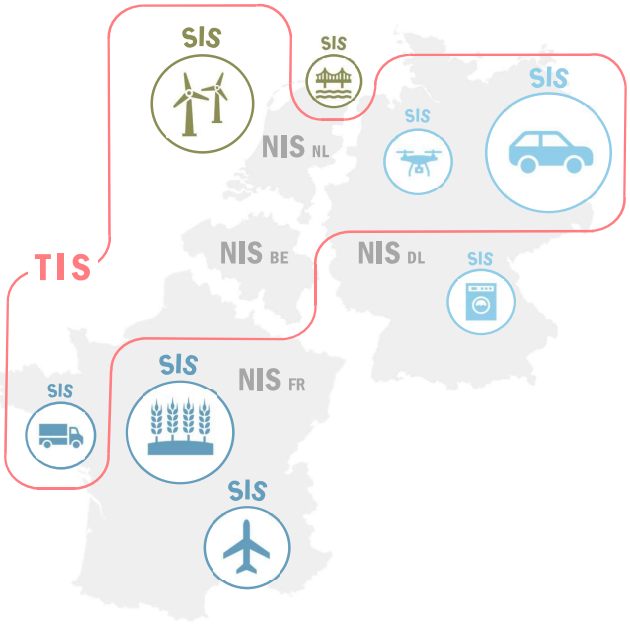
> "**a network of agents** interacting in a specific economic/industrial area under a particular institutional infrastructure or set of infrastructures and involved in the **generation, diffusion and utilisation of technology.**"

Analysing TISs, their main components and relationships provide firms, governments and non-profit organisations (to name a few) vital information on the direction of technological change within the chosen boundaries, and the speed of change (Hekkert et al., 2007). The speed of technological change is often slow - Kemp (1994) argues that this technological inertia is caused by technologies often proceeding a certain path, or trajectory. The existing technology has reaped the benefits from revolutionary improvements, socioeconomic adaption and has created the necessary surrounding infrastructure. These **technological trajectories** explain why it is so difficult to shift the direction of technological change, as is so direly needed in the transition to a CE: the introduction of new technologies often requires replacing or reconfiguring production systems, surrounding infrastructures and, sometimes, changing consumer behaviour. The government plays a large role in providing these infrastructures, shaping education policy and skill

formation (Kemp, 1994). Because a TIS enables the understanding of a complex innovative landscape surrounding technologies, empirical insights from TIS literature can significantly contribute to **government policy and innovation strategy** formulation (Bergek, Jacobsson, et al., 2008).

A TIS knows a higher level of aggregation than regional or national innovation systems, since technological innovation is not evenly distributed over space and often **transcends geographical boundaries** (Bergek et al., 2015). In Figure 2.8, I visualise a (hypothetical) TIS for telematics. Telematics is a field of technology that combines telecommunication and informatics and is widely applied in vehicle fleet management. Data is transmitted from vehicle to server, providing valuable information on location, speed, and fuel consumption (Forbes, 2023). It visualises how the innovation system transcends single sectors and national innovation systems (NIS). Hekkert et al. (2007) explain that for NISs, the number of actors, laws and events is vast which makes it challenging to study emerging innovations over time. A TIS, however, generally knows a **smaller amount of relevant actors.** Hence, Hekkert et al. (2007) argue that a TIS is the most dynamic take on the innovation system as it allows us to analyse the interactive relationship between government interventions and entrepreneurial activity, the legitimisation of technologies and resource allocation.

Figure 2.8: The boundary relationships between national, sectoral and technological innovation systems, from Hekkert et al. (2007)



As my research focuses on actors introducing a CI (of a technological nature), I argue that an innovation system where technology is the focal concept is the most suitable. The fashion industry is highly globalised, so limiting our level of aggregation to countries or regions would exclude many important actors and networks that contribute to innovation, such as European universities or parties along global supply chains. However, the touchpoints with the **sectoral innovation system (SIS)** must be acknowledged. A SIS can be described as *"a set of products and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products"* (Malerba, 2002, p. 247). Choosing to take the TIS approach does not imply complete exclusion of a sectoral perspective. According to Bergek et al. (2015), **TISs and sectors have mutual interactions.** Multiple TISs can exist in a sector, each 'responsible' for supplying the sector with novel products or process innovations. As my study takes the empirical context of the French fashion industry, there is inherently a link with the fashion SIS. However, I aim to study the introduction of CIs, which are not necessarily products. Therefore, adopting the TIS perspective allows for a broader understanding of innovation dynamics within the fashion industry, capturing the complexity of technological change beyond product innovation alone.

The Functional TIS Approach

Up until now, I have created an understanding of a TIS and explained my choice of the TIS as a theoretical framework. In this Subsection, I wish to present a subset, as you will, of my theoretical framework, which is a main contributor to my research design. Back in 2007, Hekkert et al. voiced criticism on the 'traditional' view of how innovation systems explain technological change. First, they argued that it lacked attention towards the dynamics of innovation systems. Second, they found that the framework was skewed towards explaining institutional, i.e. macro-level, influences, and much less so explaining the **contribution of entrepreneurs** - even though the latter is an essential aspect of the body of literature on innovation. In the same paper, Hekkert et al. (2007, p. 414) raised the question that led them to create the functional TIS framework: *"If we knew what kind of activities foster or hamper innovation - thus, how innovation systems function- we would be able to intentionally shape innovation processes."*

The central idea behind their framework is, as emphasised above, to explain **how innovation systems function** - i.e., mapping the activities within innovation systems that contribute to technological change within a system. These activities are called **functions,** and they make up the framework. Note that functions describe the contribution of a component to the system, hence functions only consider activities that are actually relevant to the innovation system (Bergek, 2001). The seven TIS functions are explained in Figure 2.9. Bergek, Jacobsson, et al. (2008) specified the functional approach even further, and elaborated on how the functions help us describe specific processes within a TIS. In particular, it helps us analyse the dynamics in a system and show us which interactions take place within the functions. By delineating the functions, the functional approach enables us to analyse which factors within specific functions might hinder or accelerate the development and introduction of technological innovations, called **blocking and inducement mechanisms**, respectively. In the past, the functional approach has been used to formulate policy recommendations based on the blocking mechanisms.

Bergek (2001) describes the advantages of functions being, firstly, that they allow us to describe the current state of the innovation system. Secondly, she describes how they also allow us to assess the performance of a system (which functions perform well, which ones don't?), and lastly, they prove useful for studying the system dynamics. Mapping a system's function over time provides us with a so-called **functional pattern**, which provides valuable insights into how the functions shape and contribute to the innovation system.

An Actor-Level Perspective

Usually, the TIS framework is employed as a foundation for policy recommendations (Bergek, 2019). However, some scholars argue that other than this top-down utilisation of the TIS, a bottom-up approach taking an actor-oriented perspective can provide valuable insights into the contribution of individual actors to the innovation system (Gruenhagen et al., 2022; Jansma et al., 2018; Markard & Tuffer, 2008). Coenen and Diaz Lopez (2010) agree with the latter, and add that this bottom-up perspective has the potential to provide us with useful information of **individuals' strategies and behaviour** within the larger system.

Continuing the line of reasoning described above, we have Planko et al. (2017) who confirm that the functional TIS framework applies well to entrepreneurs. However, their analysis did not go further than proving that entrepreneurs recognise the functions described in the functional approach. Jansma et al. (2018) take the functions as a starting point, and investigate whether the TIS functions are suitable to explain the dynamics of technology-oriented start-ups in the development of their innovations. Based on empirical findings from interviewing 24 start-ups, they found that the TIS functions provide a useful framework in structuring the interactions of technological start-ups. I consider the latter a **proof of concept** for my research. Gruenhagen et al. (2022, p. 2) beat me to the point by synthesising the work of Planko et al. (2017) and Jansma et al. (2018) and concluding that it is possible to use the functional TIS approach to *"establish empirical links between key innovation functions and the drivers and barriers which firms encounter in their technology innovation and diffusion endeavours".* Furthermore, Gruenhagen et al. (2022, p. 2) describe how an actor-based perspective on innovation systems allows:

> "...exploration of the **intersection of the innovation system approach,** the aim of which is to understand system functioning and propose policy recommendations, and how the enablers and barriers encountered by technology developers at the **firm level** are associated with these functional innovation processes. This also presents an opportunity to explore actions [firms] can undertake to mitigate or overcome barriers encountered within an innovation system."

In line with the above, I argue that my research is located at this intersection between the larger TIS and the individual actor within the TIS. To answer the main research question, we both need to understand the individual actions of CBSs, but also need to understand the wider landscape they operate in and the interactions they have within their respective TIS. On top of that, I argue that the actor-oriented functional pattern provides for a good structure for analysing the empirical findings from my case studies. First, it allows for identification of the individual processes and interactions CBSs engage in that shape the process of market introduction for their CI, therefore a fitting approach to answer SQ2. Furthermore, the functional pattern can be used to identify inducement and blocking mechanisms - the identification of these mechanisms enables me to answer SQ3.

Figure 2.9: The seven TIS functions explained (Bergek et al., 2008; Planko et al., 2017)

TIS Functions

Bergek et al., 2008 & Planko et al., 2017

01 Entrepreneurial experimentation

This function describes the process entrepreneurs face while **probing for new technologies or efficiencies** within a TIS. By experimentation of new applications and markets, social learnings are accumulated by observing the response of governments, competitors and consumers to the novelty.

02 Influence on direction of search

This function describes the **incentives a TIS presents for parties to enter in it.** The function is influenced by, e.g. beliefs in growth potential of the TIS, regulations and policy and expected demand. The French AGEC law is a good example of a factor that strongly influences direction of search for businesses in France.

03 Knowledge develpmt. and diffusion

This function describes the knowledge base of the TIS, its evolution, and **how knowledge within the TIS is shared, diffused or combined.** Various types of knowledge is shared, such as technological, market, scientific or logistical knowledge. Knowledge development and diffusion can happen through joint R&D projects, knowledge networks and consortia.

04 Market formation

As TISs emerge, it might be the case that the markets do not yet exist or are underdeveloped. New circular technologies often don't have competitive price propositions, and hence struggle to compete with incumbents. **Temporary niche market formations can support the introduction of such technologies** to the market, by e.g. tax incentives or government procurement plans.

05 Legitimation

Legitimation describes the TIS function of **gaining social acceptance and compliance with institutions** that are relevant to the technology. Legitimacy is often necessary for a creation of demand, and for other stakeholder within or outside the TIS to adopt the technology. For start-ups, participating in competitions can be a good way for their technology to gain legitimacy.

06 Resource mobilisation

This function describes how, in a TIS, **resources are mobilised for the development of the TIS.** Resources can include financial capital, complementary assets (infrastructure, complementary products), or human capital.

07 Development of positive externalities

The last TIS function describes all the positive externalities, or side-effects, the TIS has generated during its formation. There are many positive externalities that a TIS can evoke – **a rapidly growing TIS might induce political change, or social acceptance of a new technology.** This function is not independent, but describes how the changing nature of the TIS influences the functional dynamics of the other TIS functions.

2.5.2. A TIS is the Best Fit

In the previous Subsections, I have elaborated on the TIS that forms my theoretical background. However, there are many other approaches and frameworks coined in the literature designed to analyse innovation and sectoral change. In this Section, I set out to briefly highlight some of these approaches, and argue why I believe the TIS approach is most fitting for my research.

Majumdar et al. (2022) developed a **Triple Helix** framework for circularity in the textile and clothing supply chain. The Triple Helix is a well-known framework used to describe the process needed to capture contemporary innovation processes by means of collaboration between industry, academia and government (Cai & Etzkowitz, 2020; Hughes, 2014; Leydesdorff & Etzkowitz, 1998). It can be used to visualise how efforts made by all three institutional spheres should be integrated in terms of the subdynamics of a larger, more complex system (Leydesdorff & Etzkowitz, 1998). It is a useful tool in assessing the co-creation and co-innovation processes between the three institutional spheres, and is particularly used by policymakers as an analysis tool for national innovation policies (Cai & Etzkowitz, 2020). With that said, the Triple Helix fails to provide a **single firm with a tangible approach** on how they should move forward with their innovation. Especially considering the focal actors of my research, CBSs, who might not have a comprehensive view of the dynamics of the fashion industry yet. Majumdar et al. (2022, p. 11) confirm this argument, by suggesting further research should be done on circularity in the fashion industry by *"considering the perspectives of the brands, clothing manufacturers and textile manufacturers separately"*.

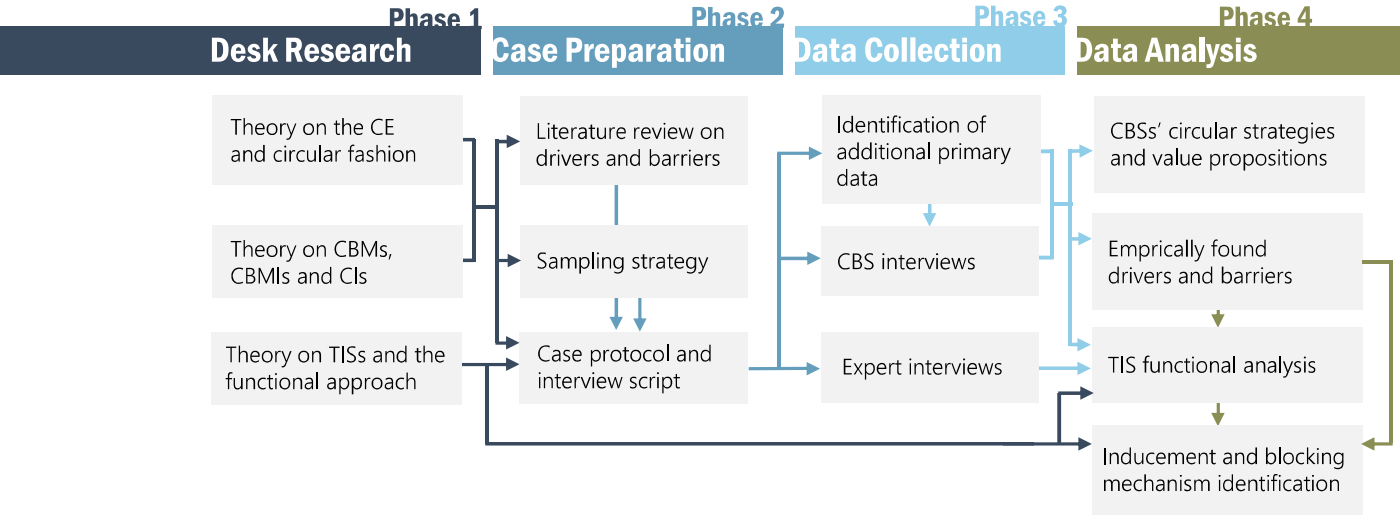
Another way to analyse the innovative landscape of the fashion industry is by taking an **Entrepreneurial Ecosystem (EE)** approach. Brydges and Pugh (2021) applied the EE to a case study of the fashion industry in Toronto, thereby creating an overview of the drivers and barriers fashion entrepreneurs face and the roles of institutions and networks. Although the EE approach allows for a micro-level perspective of the start-up, the focus of the approach is different. In EE's, the focus of the ecosystem is on the development of entrepreneurship, while an innovation system focuses on the development of a specific technology or innovation (Ianioglo, 2022).

The last framework I want to touch upon is the **Multi-Level Approach (MLP),** which is a widely acknowledged framework to describe innovation and transition processes by the interplay between the regime-level and micro-level landscape. The MLP and the TIS are comparable in terms of their basic concepts, but have different perspectives on innovation. The MLP is typically used to describe large-scale technological changes. However, it has been criticised for lacking focus on the impact and consequences of individual roles and strategies at the micro-level (Markard & Tuffer, 2008; Smith et al., 2005). Additionally, there is a gap between the niche and regime levels, making it challenging to analyse dynamics beyond niche-level innovations (Geels & Schot, 2007). Furthermore, Mills (2010, p. 445) highlights the MLP's limitations in studying how innovations developed at the micro-level diffuse from their protected niche into the broader innovation ecosystem: *"How are learning-by-doing experiences transferred beyond the niche context? How do practices replicate, scale-up or translate into other contexts of application?"*. The functional TIS approach is more suited to answering these types of questions, which are crucial for addressing the main research question.

03 Methodology

This Chapter describes my research methodology. Section 3.1 lays out the overall research strategy and the foundations for my research. In the Sections after, I discuss how the different stages of the research were carried out. Figure 3.1 depicts an overview of my research design, and outlines the structure of this Chapter. Phase 1 refers to the desk research to create an in-depth understanding of the relevant concepts, theories and approaches to investigate CI in fashion, presented in Chapter 2. Using these insights, a thorough case preparation was conducted in Phase 2. This preparation commenced with a literature review, which, together with the sampling strategy, informed the case protocol and interview script (Section 3.2). Phase 3 encompassed data collection (Section 3.3), involving interviews with CBSs and experts. Primary data on each CBS was gathered beforehand to maximise the efficiency of the interviews. Phase 4 focused on data analysis (Section 3.4). CBS-related data informed the value propositional and TIS analysis, while inducement and blocking mechanisms emerged from subsequent analysis steps. Expert interviews were used for data triangulation and to incorporate industry perspectives into the TIS functional analysis.

Figure 3.1: The three levels of analysis on drivers and barriers towards CE in the body of literature.



3.1. Research Strategy & Design

As described in Chapter 1, my research aims to understand *how* CBSs introduce CIs in fashion. For 'how' or 'why' questions on contemporary events over which a researcher has no control, a **case study**[1] is suitable (Yin, 1994). Given the scarcity of prior research on the introduction of CIs in fashion, a case study would yield empirical insights, thereby adding to the limited body of research on this topic (Yin, 2018). Given the vastness of the fashion industry and the variety of innovations, a single case cannot sufficiently answer my main research question. To gain a deeper understanding of how CBSs introduce CIs and respond to the unique aspects of the fashion industry, a **multiple-case study** is most suitable. The **empirical context** of my research is the French fashion and textile industry. I recognise fashion is a highly globalised sector, making geographic delineation seem unjust due to international collaborations and networks. However, some boundaries are needed to keep the research focused. The French fashion industry was chosen for two reasons. First, France is at the forefront of adopting CE regulations and combating fast fashion, providing a rich environment for investigation. Second, my residence in Paris during the research allowed

[1] A case study *"investigates a contemporary phenomenon in depth and within its real-world context"* (Yin, 1994, p. 13)

for proximity to key actors in the innovation system. Following Gruenhagen et al. (2022), I conduct a **multiple-product case study**[2]**.** This approach enables me to analyse various innovations diffusing into the fashion industry's innovation system. As Gruenhagen et al. (2022, p. 4) state, this method allows researchers to *"theoretically delineate a relatively homogeneous innovation system in terms of the sector, while allowing for heterogeneity among technology developers"*.

Philosophical Paradigm & Research Process

Barker (2003) defines a paradigm as a set of accepted assumptions for data gathering and analysis. This research follows **moderate constructionism**, rejecting a universal truth, embracing multiple viewpoints, and generating knowledge through dialogue and interaction (Guba & Lincoln, 1994; Järvensivu & Törnroos, 2010). **Abduction** is suitable within this research -it lies between deduction and induction, and is useful for developing new theories (Järvensivu & Törnroos, 2010; Peirce, 1966; Rashid et al., 2019). **Theory building** from case studies is suitable when little is known about the phenomenon (Eisenhardt, 1989), relevant to this research. Dubois and Gadde (2002) discuss how case studies benefit from **systematic combining** - iterating between empirical observations and theory. This was done by continuously iterating between empirical insights from the multiple-case study and the theoretical frame of TIS and circular innovation, allowing the research to remain focused and responsive to new insights (Eisenhardt, 1989).

3.2. Phase 2: Case Preparation

In this section, I elaborate on the preparatory phase for the case studies. To ensure my research built forth on the existing work, I started with a **literature review** of drivers and barriers start-ups endure while introducing innovations to the fashion industry. According to Dubois and Gadde (2002, p. 559), *"literature helps the researcher to delineate important variables, suggests relationships among them, and directs interpretation of findings"*. The methodology and literature review itself can be found in Chapter 4.

3.2.1. Sampling Strategy

Within this section, I explain my sampling strategy for the CBSs included in this research. A combination of three sampling strategies for qualitative research was used: the convenience, judgement and theoretical sample (Marshall, 1996). With respects to judgement sampling, I only include start-ups that are born circular within my sample to ensure *"the most productive sample to answer the research question"* (Marshall, 1996, p. 523). Apart from having to classify as a CBS, an additional set of criteria was used in selecting CBSs to ensure their characteristics would suit the research objective:

1. The CBS is based in France
2. The CBS has developed, or is developing, a CI with applications in the fashion and textile industry
3. The CBS has introduced, or is introducing, their CI to the fashion and textile industry
4. The CBS has a website or active social media channel through which they can be contacted

My sampling strategy aimed to include CBSs within each circular strategy (closing, slowing, narrowing) to obtain a balanced sample. Furthermore, this approach increased the extent to which the sample reflects the broad landscape of CI- and CBS types within the fashion industry. The latter follows the logic of Pal and Gander (2018), who also sample based on these circular strategies. Not only does this allow me to obtain a balanced sample and one that is aligned with sampling strategies in the literature, but it also tests the applicability of the framework for CIs in fashion, presented in Table 2.1 in Chapter 2.

The search for suitable CBSs took place from February until April 2024. Convenience sampling during this period involved utilising common connections in my network or seeking CBSs that were highly active online for a better chance of response. In the search, fashion ecosystem associations were consulted to obtain a list of companies that contributed to circularity in fashion. The networks in question were Fédération de la Mode Circulaire and Fashion Green Hub. On top of the online search, one CBS was recruited during the 3-day **ChangeNOW Summit,** which was held between 25-27 March in Paris. In total, 27 CBSs were contacted. Of those, 16 did not respond, and for 2 CBSs, communication stopped in the early communication phase. 1 CBS was recruited during the ChangeNOW summit. The initial goal was

[2]According to Carlsson et al. (2002), a multiple-product case is appropriate when focusing on a set of products that share a common market.

to include 8-10 CBSs in the sample, as I aimed to have 2-4 CBSs per circular strategy to ensure a balanced sample. After numerous rounds of contacting CBSs and increasingly exhausting the list of CBSs that fit the criteria, it was decided to stop the search and to focus on data collection with 9 CBSs. The participating CBSs, together with their circular strategy and approach, year of foundation and a short description of their CI are shown in Table 3.1. Please note that iNDUO® has two distinct CIs: innovative fabrics, and a recycling technology, which they launched under the project 'Refact'. As both are launched by the same CBS, they were treated as the same case - however, distinctions were made when findings were applicable to one of the CIs, but not the other.

Table 3.1: Overview of CBSs included in the sample. Note that 'anno' represents the year of foundation.

CBS	CE Strtgy	CE Apprch	Anno	Description of CI
itmatters	Closing	Track & Trace	2021	Technology for tracking products throughout life cycle
Recyc'ELIT	Closing	Recycling	2019	Recycling technology to recover PET from textile blends
Refact-iNDUO®	Closing	Recycling	2020	Recycling technology to recover viscose from textile blends
THE 8 IMPACT	Closing	Recycling	2021	Recycling process to recover rubber from old shoes
Weturn	Closing	Recycling	2020	Pre-recycling sorting method and digital stock manager
iNDUO®	Slowing	Design 4 long.	2014	Innovative stain, sweat and wrinkle-free fabrics
Prolong	Slowing	Care & Repair	2023	Digital tool connecting brands, consumers and repairers
[RE] PAIRE	Slowing	Care & Repair	2022	Digital tool, logistics mgmt. and shoe repair for brands
EverDye	Narrowing	Reducing	2021	Dyeing technology reducing emissions and toxic chemicals
Iroony®	Narrowing	Reducing	2018	Process to transform hemp stalks to cellulosic pulp

3.2.2. Case Protocol & Interview Script

To ensure a consistent approach to each CBS, an extensive **case protocol** was constructed, which can be found in Appendix A. The case study protocol format of Yin (2018) was followed, and the case protocol was completed before interviews with CBSs commenced. Within the case protocol, an **interview script** was constructed (Section A.3.1 in Appendix A). As the interviews were of semi-structured nature, the interview script acted as a guideline during the interviews. The TIS functions, or the TIS in general, were deliberately not mentioned in the questions/interviews to avoid response bias. Although the TIS functions did help structure the interview questions, the semi-structured nature of the interviews left room for the conversation to take unexpected twists or to follow interesting, unscripted, lines of investigation. As the interview process progressed, the interview script was refined or updated iteratively based on learnings from previous interviews, for example if certain questions were perceived as unclear by interviewees.

3.3. Phase 3: Data Collection

To reach my research objectives, as an in-depth understanding of the characteristics of 9 CBSs, their processes and interactions and their context had to be understood. To do the latter, semi-structured interviews were conducted and primary data was gathered on each case. The data collection methodology for the CBS and expert interviews and the primary data search can be found in this section.

3.3.1. Primary Data Collection

The inclusion of primary data sources beyond the interviews in my research serves four purposes. First, it enables **data triangulation**. Second, it increases the **amount of data** in my analysis, allowing for more comprehensive and insightful findings. Third, it helps to **reduce recall bias**, as interviewees might forget or omit details from past processes and interactions that deemed important for the introduction of their CI. By reviewing primary data, such as older news articles or podcasts, I reduced this bias (Brassey & Mahtani, 2017). Fourth, it balanced discrepancies in information availability, as interview lengths varied significantly. For instance, the itmatters interview was four times longer than Recyc'ELIT's (Table 3.2), but more online information was available for Recyc'ELIT, which balanced the cases.

For each case, the main source of primary data that proved useful for my research was their CBS's **LinkedIn page**. This did not only contain direct outputs from the CBS, but also often contained links to podcasts/panel discussions/news articles/interviews featuring them. Other than LinkedIn searches, general Google searches were conducted to gather data on each case. It must be noted that most LinkedIn

posts, news articles and podcasts were in French. For LinkedIn posts and articles, a language transcription software (DeepL) was used. Podcasts and panel discussions were recorded and transcribed using Microsoft Teams, which provided an accurate French transcription. Subsequently, this transcription was translated with the same translation software. The above ensured all data was available for data analysis in English.

3.3.2. Interview Data Collection

Once the case preparation phase was completed, the 9 CBSs were contacted to schedule an interview at their convenience. Table 3.2 shows the interviewee's position and duration of the interview for each CBS. In total, **11 CBS semi-structured interviews** were conducted with an **average duration of 1 hour**.

Before the interviews, interviewees were sent a list of themes and high-level questions to give them an idea of what the interview would entail. The interview script was deliberately not sent to avoid bias, or the misinterpretation of the questions (as I would not be able to clarify any uncertainties of the questions directly). All interviews were conducted in English, and all but 1 interview were conducted online. For the online interviews, the **built-in recording and transcription function of Microsoft Teams** was used. For the in-person interview, a Microsoft Teams meeting was started to ensure a similar recording method between cases. An additional measure for a quality recording was a phone recording with the phone on aeroplane mode to avoid the recording to be uploaded to the cloud. Even though explicitly stated in the ICF, interviewees were all asked permission again during the meeting before recording the interview.

Table 3.2: The interviews conducted during the research. The entries above the line show CBS interviews, below show expert interviews.

CBS	Interviewee	Duration
itmatters	Founder	2 hours
Recyc'ELIT	Founder	0.5 hour
THE 8 IMPACT	Co-founder	1 hour
Weturn	Employee	1 hour
iNDUO®	Co-founder	1 hour
Prolong	Co-founder	2x 0.5 hour
[RE] PAIRE	Co-founder	2 hours
EverDye	Co-founder	2x 0.5 hour
RBX Créations	Co-founder	1 hour
PWNEW Agecy	C-suite	1 hour
The CIF	Partner	0.5 hour

After the interview, the interview transcriptions were downloaded and cleaned - the transcription software often struggled to recognise French place names and brands. If necessary, the recording was consulted to ensure the proper names were used. If the recording did not provide additional clarity, the interviewees were asked to provide the proper names/brands. All transcriptions were sent to the interviewees for **review** - this gave them the opportunity to retract/add any statements made, and check for inaccuracies. The latter improved the quality of the transcriptions, which is desirable, since the interview transcripts formed the main source of information for data analysis.

Expert Interviews

In addition to the 11 CBS interviews, **2 expert interviews** were conducted. The position of the interviewee and duration of these interviews can be found in Table 3.2. The expert interviews were conducted to (1) triangulate the findings from the CBS data, and (2) provide additional insights from the experts' experience:

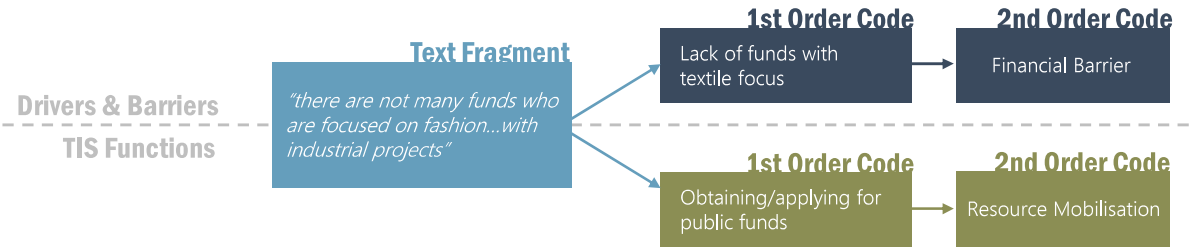
- The first expert interview was with an investor of the **Circular Innovation Fund** (CIF). The CIF is a global venture capital (VC) fund, dedicated solely to circular innovation, aiming to positively impact climate change mitigation and promote the circular use of resources (Circular Innovation Fund, 2022). This interview was online, and the same protocol was used as for the CBS interviews.
- The second expert interview was to obtain a perspective from a fashion industry expert; a C-suite manager from the **PNEW Agency**, a creative eco-responsible consulting agency, and currently a board member of the Féderation de la Mode Circulaire. This interview took place in person, and was not recorded due to a noisy environment. Instead, detailed notes were taken and cross-checked with the interviewee after the interview.

I learned of the existence of the CIF at a panel discussion on impact investments during the ChangeNOW summit, and contacted them shortly after to see if they would be open to an interview. I connected with the fashion industry expert through ENAMOMA, the university program I participated in.

3.4. Phase 4: Data Analysis

All interview transcripts and additional primary data were gathered in an ATLAS.ti project. Coding of the qualitative data was also done on **ATLAS.ti**, which allowed for a structured and transparent approach. In line with an abductive approach, coding and data collection were not consecutive steps, but were conducted in parallel over the course of two months. In total, four rounds of coding were completed: the first two rounds focused on generating a wealth of 1st order codes. The third round consisted of merging highly similar codes and categorising codes under the 2nd order codes (see Figure 3.2). The fourth and fifth round of coding focused on ensuring data across all 9 cases were coded in similar fashion. Occasionally, distinctions between certain 2nd order codes were unclear. For example, a lack of public funding could be categorised as either a 'financial' or 'regulatory and policy' barrier. These ambiguities were addressed by consistently coding text fragments with similar meanings in the same way.

Figure 3.2: A coding example with a text fragment from an interview transcript. It shows how each text fragment receives 4 codes.



As detailed in Chapter 2, the TIS formed the theoretical framework for data analysis. Figure 3.2 illustrates how interview transcripts and additional primary data were coded. When a fragment contained a driver or barrier, four codes were assigned: a 1st order code for the specific driver or barrier, and a 2nd order code for the category (see Chapter 4 for categories). Additionally, each text fragment was coded according to the theoretical framework, with a 1st order code for the process or interaction described, and a 2nd order code for the corresponding TIS function. When a text fragment suggested a process or interaction, but not a driver or barrier, it was coded using only the codes corresponding to the bottom half of Figure 3.2.

3.5. Validity and Reliability

Throughout the research, numerous measures were taken to maintain a high level of research quality. To establish **construct validity**, multiple sources of evidence were consulted when crafting the case reports. Additionally, multiple interviewees were asked to review their sections in the Case Report, contributing to construct validity by reviewing the operationalisation of processes, interactions, drivers, and barriers. This review process ensured that any misinterpretations on my part were flagged and corrected (Yin, 2018). The feedback from the CBSs has not (yet) resulted in any large changes in the Care Report, but were especially helpful in identifying any important processes or interactions that were initially not included.

To cross-examine the events and processes identified in the interviews, I **triangulated** the interview data with other primary sources such as the CBS's website, news articles, social media channels and expert interviews. This triangulation provided robust evidence of data quality (Williams & Morrow, 2009). Within data triangulation, the majority of the data was in French. For written data, DeepL was used to translate. To be able to reliably use the audio data, I played the audio fragment on speaker while a Teams meeting was running, which allowed for transcription in French and subsequent translation to English. To mitigate data collection bias, I ensured I used the same data collection procedure for each CBS. Furthermore, to ensure the **reliability** of my research, I created a case study protocol that guided the investigation in each case. An extensive case study database was built and maintained in ATLAS.ti, containing documents, codes, and memos with information on coding, data collection, and other factors influencing data analysis. ATLAS.ti proved invaluable as it tracked all changes made to codes, allowing for retrospective review.

Abductively, the research direction evolved during the study as empirical observations influenced theoretical views (Dubois & Gadde, 2002). However, a criticism of this systematic combining is its black-box nature (Kvale, 1997). Dubois and Gadde (2002) suggest **describing systematic combining efforts** within the results - the latter was embraced in this research and can be read in Section 5.5.

04 Literature Review

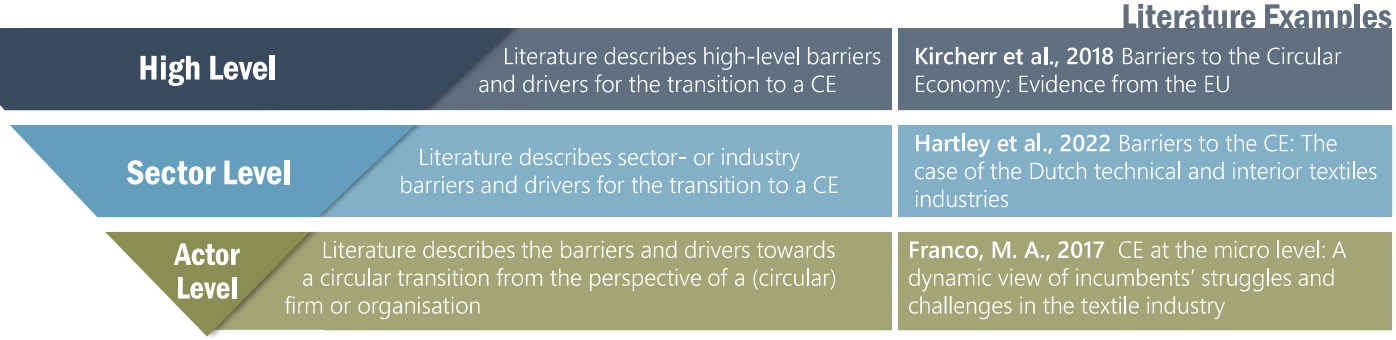
This chapter presents the literature review for my research, for which I have analysed 7 academic publications and 8 non-academic sources addressing, all in their own way, the introduction of innovations in the fashion industry. Section 4.1 describes the justification for conducting the literature review; Section 4.2 delves into the literature selection process, and Section 4.3 presents the identified drivers and barriers.

4.1. Why this Literature Review?

The drivers and barriers to the transition to a CE are widely covered in academic literature. Arguably the most well-known work is by Kirchherr et al. (2018), who conducted a large n-study on identifying CE barriers in the European Union, where they found that lacking consumer interest and hesitant company culture as most pressing. These findings provide invaluable insights into the problems and opportunities in moving towards a CE. However, they are too high-level for us to be able to draw accurate conclusions for fashion CBSs - in this Section, I set out to explain why.

First of all, Kirchherr et al. (2018) and Dissanayake and Weerasinghe (2022) argue that **barriers and drivers for the CE transition differ per sector.** Considering my research objectives, I want to analyse CI introduction for fashion in particular. Evidence to support my rationale can be extracted from comparing Kircherr's (2018) widely cited findings with publications that focus on drivers and barriers to CE within fashion: Kirchherr et al. (2018) argues that technological barriers do not form core barriers within the transition to the CE. However, within the literature on circularity in fashion, many publications do suggest that technological gaps in recycling, remanufacturing and sorting processes form critical barriers in the transition to circularity (Dissanayake & Weerasinghe, 2022; Sandvik & Stubbs, 2019).

Figure 4.1: The three levels of analysis on drivers and barriers towards CE in the body of literature.



Drivers and barriers towards a CE can be evaluated from multiple levels, as illustrated in Figure 4.1. Although the findings from the highest level of analysis are meaningful, they are **not sufficiently focused** to answer the questions I pose in my research. Let me illustrate with an example: technological barriers, such as the inability to scale sustainable technologies, are often identified in fashion-specific research. However, I set out to understand why these innovative technologies are not yet scaled or widely adopted. What drives or blocks the scaling and introduction of such technologies? Engelen (2023, p. 41) confirms my concerns, in stating that these more high-level studies *"can provide insight into the main causes of the slow transition to CE, [but] they do not provide insight for specific innovations or industries into what the biggest barriers to a CE transition are"*. To address this gap, my approach extends the approach of Hartley et al. (2022). They recognised the limitations of CE drivers and barriers being aggregated at the macro-level and thus added granularity to Kircherr's (2018) approach by targeting the technical textile sec-

tor specifically, hence placing themselves in the 'sector level' in Figure 4.1. Within these sector-level drivers and barriers, they distinguish between the firm-level and industry-level. My approach adds a higher level of granularity as I specifically identify actor-level barriers and drivers experienced by CBSs in fashion. In that sense, my approach is highly similar to the approach taken by Franco (2017), who evaluates the bottlenecks incumbents in the textile industry face regarding their ability to go fully circular.

Lastly, within the body of literature on the CE in fashion, many scholars have analysed the drivers and barriers to introducing CBMs or CBMIs. In Chapter 2 I described how CIs and CBMIs relate, and how while a change in one of them might induce change in the other, they are not the same. The latter is illustrated by how, for example, technological innovation is often described as a barrier or enabler (a means to an end), instead of **an end in its own right** (Dissanayake & Weerasinghe, 2022; Todeschini et al., 2017). Within this review, I want to shed light on the drivers and barriers of start-ups introducing CIs within the fashion industry - the latter requires examining drivers and barriers that consider CI introduction as an end.

As described above, the current body of literature does not provide sufficient depth and specificity into the drivers and barriers CBSs face when introducing CIs in fashion. Other than searching for more depth and specificity, I conduct this literature review for the following reasons:

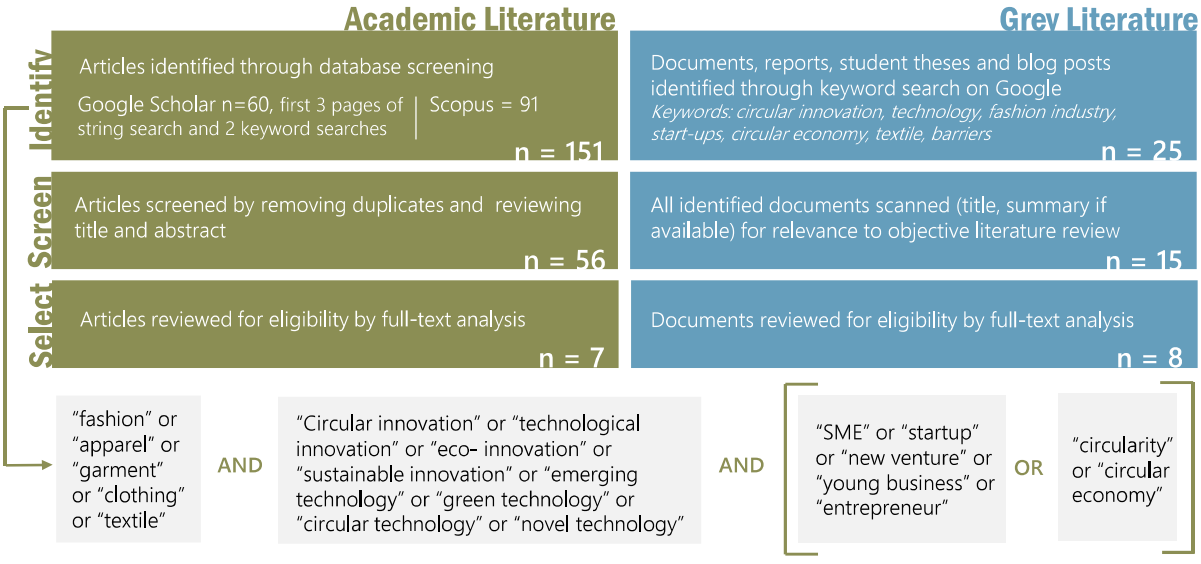
- To **shape my case study design.** Having a tentative framework of the drivers and barriers CBSs experience provides a useful foundation for developing the case and interview protocol.
- To thoroughly **survey the existing body of literature** concerning CI introduction among (CB)Ss in fashion within the context of the CE. This comprehensive overview not only illuminates the current state of research but could also identify gaps and areas for further investigation.
- To enable me to, after my case study, analyse whether my empirical findings have made **additional contributions** to drivers and barriers which have not yet been identified.

Section 4.2 delves into the method of literature selection, along with the selection criteria and final list of academic and grey literature which is included in the literature review.

4.2. Literature Selection

As stated in the previous Chapter, CI is a relatively new concept within the academic literature, and especially within the entrepreneurial landscape of the fashion industry. The latter forms the main reason for me including both **academic and grey literature** in my literature selection - there is simply not enough academic literature to draw from that is sufficiently relevant to my research. Figure 4.2 shows the selection process for articles and grey literature to include in the literature review, and how I used string and keyword searches to create my initial screening of 151 academic articles and 25 sites and online reports.

Figure 4.2: An overview of the article and report selection process, including the key word searches used.



Scopus and Google Scholar were used for the academic literature, and a simplified version of the keyword search in Figure 4.2 was conducted on Google. Eventually, my initial screening was formed by utilising **keyword searches and exploratory and targeted search.** From an initial selection of 151 academic articles and 25 documents, reports and websites, I eventually included 7 articles and 8 items from grey literature in my literature review. In the following section, I would like to elaborate on the selection criteria I adhered to that allowed me to reach this final selection:

1. The literature had to concern **the fashion industry.** Since the barriers and drivers to CE can differ per sector, it was adamant to filter on fashion industry-specific articles, publications and websites to ensure maximal relevance to my research. Even though all keyword/string searches included the term 'fashion', 'textile' or 'garment', many articles were still not sufficiently related to the fashion industry. These were excluded from the literature review.
2. The literature had to address either **start-ups in fashion,** or **innovative technologies in fashion**. The rationale for this is as follows:
   (a) Articles that address start-ups in fashion, even without a technological innovation focus, can provide valuable information on drivers and barriers start-ups might endure within fashion that could enhance or block the introduction of a CI.
   (b) Articles that address innovative technologies in fashion could provide insights into drivers and barriers related to the adoption and diffusion of the technology within the industry. Critical assessment is needed per driver and barrier to assess whether they would apply to startups a barrier describing the technological lock-in linear incumbents suffer from is to a much lesser extent applicable to start-ups, for example.
3. The article or document had to address, in one way or another, **drivers and barriers** on introducing circularity or technology in the fashion industry. Many articles were excluded because they presented a list of emerging technologies in fashion, without evaluating possible bottlenecks in their introduction. An example of this is the work by Ikram (2022). Although highly valuable in understanding current technological trends in the fashion industry, it does not provide the insights needed to review the drivers and barriers present when introducing technology in fashion.
4. Literature had to address drivers and barriers at either the technology or actor level. Many of the identified articles provided general drivers and barriers on the transition towards a CE in fashion without any insights on how, or which, actors relate to these drivers and barriers. Hence, **articles describing solely high-level or sector level drivers and barriers were excluded.** An example of an excluded article is the work by Dissanayake and Weerasinghe (2022), which, although presents an in-depth analysis of the barriers and enablers of moving towards circular fashion, is less relevant for the actor-oriented perspective of this literature review.

The search string from Figure 4.2 yielded 91 results on Scopus on 14-03-2024. A search on Google Scholar was also conducted with the same search string as I used for the search on Scopus. After, I performed two more keyword searches using the keywords listed under 'grey literature' in Figure 4.2. For each search, I reviewed articles on the first 3 pages, which lead to a total number of 151 academic articles up for screening. The title and abstract of all articles were scanned to review their relevance to the criteria listed above. The articles that passed the initial screening were read in full to assess their eligibility. In the end, 7 academic articles and 8 online reports and website posts were found eligible, and can be seen in Table 4.1.

Reviewing Methodology

Table 4.1 lists the articles, publications and reports I found to be insightful for developing a tentative list of drivers and barriers for CI introduction amongst CBSs in fashion. The top half of the table lists publications from the academic literature, while the bottom half shows the relevant grey literature. In this section, I elaborate on the method of obtaining the drivers and barriers from my literature review:

1. The individual articles were read thoroughly. **Text fragments or tables** that included either a driver or barrier were registered. At this point, no barriers or drivers were categorised or excluded.
2. Once all articles were read and all text fragments noted, I **critically assessed** each barrier and driver and reviewed whether they would be relevant for CI introduction by CBSs in the fashion industry. For example, Piller (2023) conducted several interviews with fashion start-ups in Australia - of her sample, only one start-up was of technological nature. Hence, only the drivers and barriers that

the technology start-up acknowledged were included in my literature review. Other reasons for excluding certain drivers or barriers were that they targeted linear incumbents in fashion, or were focused on creativity in the design-sense, as opposed to innovation.

3. Once all drivers and barriers for all articles were assessed, I **summarised each one**. Highly overlapping drivers and barriers were merged, and in some cases, the original articles were revisited to assess whether certain drivers or barriers differed sufficiently to be distinguished from one another. After this step, 56 barriers and 30 drivers were identified.
4. The final step involved **inductively categorising** drivers and barriers based on their nature. After multiple rounds of categorisation, I came to a final list of 7 categories: market and economic-, technological-, policy and regulatory-, social and cultural-, operational and organisational-, knowledge and information-, and financial drivers and barriers.

The drivers and barriers are deliberately **not categorised according to the 7 TIS functions.** The first reason is to avoid bias. A certain level of assumption is required to place a specific driver or barrier under a TIS function, without confirmation by a stakeholder in the fashion industry. Categorising a driver or barrier within a certain TIS function from the start might have biased my case study by influencing interview scripts, for example. Gruenhagen et al. (2022) confirm this by arguing that the identification of drivers or barriers does not always fully explain the actual innovation processes that are affected.

Table 4.1: The selected articles. The top half lists the academic literature, the bottom half the grey literature.

Article	Author
Achieving a Circular Textiles Economy Facilitated by Innovative Technology	Turnbull et al. (2021)
Designing for circularity: Sustainable pathways for Australian fashion SMEs	Piller (2023)
Fashion Companies Pioneering with Eco-Innovations in the Swedish Fashion Industry: Motivations, Resources, and Cooperation	Le Feber and Smit (2023)
Entrepreneurial Practices in Eco-Innovation: Circular Challenges Related to the Tomato Textile Project in the Netherlands	Lommerse and Loots (2022)
A Life Cycle Thinking Approach to Analyse Sustainability in the Textile Industry: A Literature Review	Luján-Ornelas et al. (2020)
Innovative and sustainable business models in the fashion industry: Entrepreneurial drivers, opportunities, and challenges	Todeschini et al. (2017)
Closing the Loop: Intentional Fashion Design Defined by Recycling Technologies	Ninnimäki (2018)
The Paradox of Innovation in Fashion: The Case of Renewcell	Ten Napel (2024)
Supporting Sustainable Fashion Designers, Start-Ups and SMEs in the CE	Fashion for Change (2021)
The Challenges Fashion Entrepreneurs Face when Entering the Fashion Industry	Almanza and Van den Berg (2016)
Support Report Mapping Sustainable Fashion Opportunities for SMEs	European Commission (2019)
CE in the Textile Industry: Transition theory in start-ups in the textile industry	Snoek (2017)
OP-ED: Innovations in Fashion, Moving Beyond Solutions Searching for Problems	FashNerd (2024)
A New Textiles Economy: Redesigning fashion's future	Ellen Macarthur Foundation and Circular Fibres Initiative (2017)
Mainstreaming Recycled Textiles: An analysis of drivers and barriers for circular business model diffusion in the Dutch apparel industry	Baltussen (2019)

4.3. Drivers & Barriers

When evaluating the drivers and barriers to CI introduction by CBSs, there are two distinct perspectives to consider. First, the distinction between **internal or external** drivers and barriers. Drivers and barriers can either be due to the nature of start-ups, or occur outside the start-up (Hartley et al., 2022). So, even though I take a micro-level perspective in my literature review, I do aim to identify industry-level

barriers that impact CBSs introducing CIs. For example, barriers and drivers might exist due to the inherent nature of a start-up (e.g. above-average flexibility due to its smaller size), independent of the external environment. Secondly, it is important to realise that firms that innovate perceive the barriers to innovation differently than those that do not (Gruenhagen et al., 2022). Hence, the second distinction is made based on the respective category of the driver or barrier, as described in the previous section. In the following subsections, I describe the drivers and barriers according to the 7 categories.

4.3.1. Market and the Economy

The first category I will be exploring is regarding market and economical influences on CI introduction in the fashion industry. It is important to consider the state and dynamics of the market when analysing the introduction of CIs in fashion, as 1) the fashion industry's market dynamics are driven and blocked by unique factors, and 2) the market dynamics eventually determine the demand for circular solutions.

Market and Economy Barriers

Considering the market and economic situation surrounding CIs in fashion, the most prevalent external barrier in the literature is the **industry's slow response to sustainability** (Fashion for Change, 2021; FashNerd, 2024; Lommerse & Loots, 2022; Ten Napel, 2024). Ten Napel (2024, p. 1) reflects that *"innovations ...require the industry to venture into uncharted territory, both technologically and in terms of business models...Unfortunately, the comfort of established practices and the fear of disrupting the status quo often prevail, leaving transformative ideas to wither on the vine"*. The adaption of innovations often comes with a paradigm shift, and that is what is so difficult to achieve in fashion. Snoek (2017) explains that fashion has fixed ways of working due to short, seasonality-bound time frames, its infrastructure, and prevalent fast fashion business models, making it extremely challenging for start-ups to succesfully integrate their technology (Fashion for Change, 2021; Luján-Ornelas et al., 2020; Snoek, 2017).

The **unfair competition** start-ups endure from fast fashion from another barrier. Fashion for Change (2021) explain that linear, fast fashion products benefit from the competitive advantage gained from the non-internalised costs of environmental impacts, resulting in more competitive pricing. This unfair competition is not solely relevant for CBSs producing garments, but also forms a barrier for CBSs developing recycling technologies, for example. Ninnimäki (2018) argue that increased competition in collecting and recycling practices results in lower prices, making it more challenging for start-ups to remain competitive. Another barrier for start-ups is that many linear incumbents **don't consider circularity a strategic priority.** Although there are linear incumbents that invest in sustainable or CIs, Snoek (2017) found in an interview with Dutch CBS DyeCoo[1] that they can display defensive investment strategies. The latter implies investing in a product or technology to ensure it does not become a threat to the inbcumbent's market. While DyeCoo had secured investments from Nike and Adidas, DyeCoo expressed that *"they have invested to show they do something about sustainability and let the development die slowly"* (Snoek, 2017, p. 49). Todeschini et al. (2017, p. 770) summarise that *"incumbents are relatively effective in establishing competitive advantages but less able to identify new opportunities and change accordingly, while startups are inherently more innovative but less successful in developing competitive advantages"*.

The last external barriers are regarding **demand and price.** Ninnimäki (2018) claims that there is still a lack of demand for recycled materials. On top of that, circular products or services often come with a higher price tag, which disincentivises price-sensitive customers (Piller, 2023; Turnbull et al., 2021). Le Feber and Smit (2023) even identified the lack of demand as one of the most limiting factors within their study on EIs in the Swedish fashion sector. They explain how this inhibits start-ups in meeting production minima requested by suppliers (see Organisational Barriers). An internal barrier was the difficulty for start-ups to measure (and hence prove) the **impact of their innovation.** Often, industry stakeholders want to see a Life-Cycle Analysis (LCA) of the innovation to gain insights into the innovation's potential impact, but these are challenging, time-consuming and expensive for start-ups to conduct. Fashion for Change (2021, p. 12) describes how the latter results in a chicken-and-egg situation for start-ups: in such a highly competitive market as the fashion industry, these LCAs are a *"must-have for brands to gain trust from consumers and investors and hence gain a competitive edge."* However, start-ups often don't have the budget and time to conduct LCAs, but have a hard time findings investors or partners without them.

[1] DyeCoo developed a textile dyeing technology that does not require the use of water of chemicals (Snoek, 2017)

Market and Economical Drivers

The external drivers can generally be described as an **increasing demand for sustainable and circular products and services,** both amongst consumers and industry players. Turnbull et al. (2021) argue that there is a growing sentiment among consumers to the acceptance of recycled materials, especially amongst the younger generations. Start-ups' circular technologies, by themselves, are becoming a source of competitive advantage in an environment where customers increasingly demand responsible production of their garments (Le Feber & Smit, 2023). Luján-Ornelas et al. (2020) add to this by describing how new technologies can satisfy new customer needs, such as self-cleaning textiles.

4.3.2. Regulation and Policy

Almost all reviewed literature mentioned the role regulations and policies play in either blocking or adopting circular solutions in fashion. In this section, I will elaborate on how regulations and policies influence the ability of CBSs to introduce CIs according to the reviewed literature.

Regulatory and Policy Barriers

Across all categories, the most mentioned external barrier within the studied literature was the lack of **industry-specific regulations and policies** for adopting circular solutions in fashion (Ellen Macarthur Foundation & Circular Fibres Initiative, 2017; European Commission, 2019; Luján-Ornelas et al., 2020; Piller, 2023; Snoek, 2017; Ten Napel, 2024; Turnbull et al., 2021). Piller (2023, p. 6) adds that the non-existence of comprehensive regulations doesn't only form a barrier to introducing innovations, but also *"form[s] a barrier to value creation mindsets in a CE",* implying that it inhibits innovation in the first place. Adding to this, Turnbull et al. (2021) explain how the lack of consistent regulations concerning recycling standards currently inhibit efficient infrastructures between countries that enable, for example, start-ups to obtain quality feedstock for their own remanufacturing or recycling processes. However, regulations for recycling alone do not cover the necessary load: regulations regarding traceability, transparency, production processes and waste are all critical in stimulating a circular transition.

A barrier I categorise under regulation and policy, is the **absence of transparency and traceability in fashion**, which currently forms both an external and internal barrier for start-ups. From an external point of view, start-ups require traceability and transparency in the supply chain to sufficiently adapt their technology to form a good fit with current processes. Internally, the lack of transparency and traceability make it difficult for start-ups to establish transparency and traceability within their own solutions, and render it challenging to determine the impact of their own innovation (Almanza & Van den Berg, 2016). Lastly, in line with the barrier of conducting LCAs as mentioned previously, start-ups endure similar barriers when applying for **governmental or other eco-labels.** Fashion for Change (2021) explain how they are time-consuming and costly to obtain, making it internally challenging for start-ups to legitimise their innovation.

Regulatory and Policy Drivers

Baltussen (2019) and Fashion for Change (2021) describe how external pressures from NGOs or other civil groups can form drivers for industry players to take more circular measures. Additionally, policy and regulatory interventions are essential in driving the adoption and integration of innovative technologies for the CE (Ellen Macarthur Foundation & Circular Fibres Initiative, 2017; European Commission, 2022; Fashion for Change, 2021; FashNerd, 2024; Luján-Ornelas et al., 2020). Furthermore, Luján-Ornelas et al. (2020) describe how international standards, aligned with regional norms and laws, can help achieve transparency and traceability. Furthermore, even if there are currently no global regulations in place for ensuring sustainability in fashion supply chains, numerous eco-labels exist to guarantee certain standards of production. Luján-Ornelas et al. (2020) describe how **eco-labels can promote more sustainable and responsible manufacturing practices.** Currently, multiple acknowledged eco-labels exist for the fashion and textile industry, such as the Global Organic Textile Standard and OKEO-TEX.

Le Feber and Smit (2023, p. 1894) state that *"eco-innovations can be pushed by formal legislation and regulation".* Within their study, they found that many eco-innovative firms use existing regulations, strategies, and environmental goals and commitments as a framework for their contribution to sustainability. Lommerse and Loots (2022) provides additional insights by arguing that trust in the institutional environment are essential for start-ups with innovative projects to overcome the 'valley of death' (Veerman,

2022). Furthermore, European Commission (2019) propose that standard regulations targeted to **simplify the administration processes** for new technologies could reduce the regulatory barriers for start-ups. Other than administrative drivers, radical innovations hold the potential to induce system-wide change, which is recognised by governments (Lommerse & Loots, 2022).

4.3.3. Finance

The market size of the fashion and apparel market is expected to hit almost **1.8 trillion US dollars** in 2024 (Statista, 2024). In 2023, LVHM alone achieved revenues of over 85 billion US dollars (Fashion Dive, 2024). It is safe to say the fashion industry, as a whole, doesn't lack the financial resources to instigate a circular transition. In this Section, I will identify what financial drivers and barriers the literature coins.

Financial Barriers

The external barrier that was mentioned most frequently in the grey literature, was the **strong industry preference for short-term investments,** even if investments into circular solutions could have better returns in the long run (FashNerd, 2024; Lommerse & Loots, 2022; Ten Napel, 2024). Ten Napel (2024) explains that many incumbents avoid making long-term investments in sustainability, as the returns are often not immediate. He adds that in stead, incumbents opt for 'quick wins' to positively contribute to their brand image, but do not imply large changes to their supply chain. Lommerse and Loots (2022) adds that the fashion industry struggles to look beyond the 'value-added'[2], and subsequently fails to recognise the 'value retained' by used products at the environmental and societal level. This challenge persists due to the strong focus on downstream value chain activities in the linear economy, rather than considering upstream retention of resources and materials in a circular fashion.

I want to briefly reflect on how the above was mostly mentioned within grey literature, i.e. two master theses and online blog posts. For both the master theses and the blog posts, empirical insights were generated. This goes to show that new barriers and drivers can be found in empirical research, and it is worthwhile to dig deep to identify how the idiosyncratic characteristics of the fashion industry impact start-ups. The **defensive investment strategies,** as described under 'Market and Economical Barriers' are closely linked to the above, as they involve incumbents making short-term investments to circumvent the threat innovative start-ups pose. Ten Napel (2024) provides another perspective on the less-than-beneficial investing habits that unfortunately remain dominant in fashion: the obstacle of financial allocation. He explains that a significant amount of incumbents' budgets is allocated towards PR and marketing, which dwarfs the investments made towards sustainable and circular R&D projects.

The above provides some explanation of why fashion start-ups struggle with raising sufficient funds for the development of their innovations. This **lack of access to financing** (European Commission, 2019; FashNerd, 2024; Ten Napel, 2024), together with the high up-front costs of developing and introducing an innovative technology (Baltussen, 2019; European Commission, 2019; Fashion for Change, 2021; FashNerd, 2024; Snoek, 2017; Turnbull et al., 2021), form a large external and internal barrier for start-ups. Especially for circular start-ups, cash flow forms a critical issue. One of the explanations for the latter is the **delay in revenues.** For linear business models, the costs are quickly paid back by the sales revenues (Fashion for Change, 2021), while for innovations, the start-up only generates revenue when the technology is fully functional (Almanza & Van den Berg, 2016). An internal barrier for start-ups is the trade-offs they must make due to limited financial resources. In her interviews with Dutch fashion start-ups, Snoek (2017) found that it was difficult to **choose between R&D and other essential activities,** such as marketing their innovation.

Financial Drivers

In the literature, I found two main sources of funding that were identified as drivers within the finance category. Firstly, Ten Napel (2024) pitches the idea of **industry-wide funds or consortia,** especially directed towards funding development projects or sustainable materials or recycling technologies. Secondly, the government plays a large role in driving R&D in circular fashion by means of **resource allocation or other financial incentives.** Governments should provide more financial support for circular fashion start-ups in the form of grants for innovative projects, or by alleviating certain financial burdens with **tax incentives**, for example (European Commission, 2019; Fashion for Change, 2021).

[2]Value-added refers to the value firms generate through linear systems.

4.3.4. Technology

Considering the technological nature of CIs, start-ups face both technology-related internal and external influences that dictate if, and how well, their CI is adopted by the fashion industry. The following Section delves into the technological barriers and drivers I identified from the literature.

Technological Barriers

The most-mentioned external technological barrier within my literature review was the **lack of supportive infrastructure for the technology** (Ellen Macarthur Foundation & Circular Fibres Initiative, 2017; European Commission, 2019; Fashion for Change, 2021; Luján-Ornelas et al., 2020; Piller, 2023; Snoek, 2017; Ten Napel, 2024; Turnbull et al., 2021). An example of the need for a supportive infrastructure is provided by Ellen Macarthur Foundation and Circular Fibres Initiative (2017): to reduce the amount of (plastic) microfibres released into our waters, entrepreneurs had developed special washing machine filters to capture microfibres in a wash cycle. However, introducing this filter into households would imply retrofitting millions of washing machines, and would require a switch of laundry detergent to avoid blockage of the filter (Ellen Macarthur Foundation & Circular Fibres Initiative, 2017). This example describes how sometimes, the total infrastructure surrounding a technological solution, even as simple as a washing machine filter, needs to be re-designed to facilitate its positive impact.

To emphasise the difficulty of introducing innovations in fashion, FashNerd (2024, p. 1) compares the fashion industry to the finance industry, and explain that *"the difference lies in the readiness of each industry to adopt and adapt to new technologies; finance's infrastructure is inherently more conducive to digital innovations than fashion's dispersed and varied supply chain".* For recycling start-ups specifically, the lack of standardised recycling processes and technologies significantly hinders the adoption and scaling-up of an innovative technology, and the large variation in quality and blend of discarded textiles makes it difficult to adopt a 'one-size-fits-all' technological solution (Baltussen, 2019; Ninnimäki, 2018). Another valid explanation of the low technology readiness levels in the fashion industry can be attributed to the **lack of technological expertise** within the industry. Baltussen (2019) found that Indian manufacturing companies would want to invest in recycling technologies for their factories, but simply did not possess the appropriate technological expertise to know what technologies would be suitable.

For start-ups internally, a significant barrier is **scaling up their technology** (Baltussen, 2019; Snoek, 2017). This can have multiple reasons: it could be too expensive to scale the technology (Baltussen, 2019), the start-up might not have access to proper facilities for scaling-up, the technology in itself is not ready for scaling (Snoek, 2017), or the infrastructure to support the larger scale is not in place (Ellen Macarthur Foundation & Circular Fibres Initiative, 2017). To add to this, start-ups face the challenge of designing circular products and processes being much more complicated than designing for the linear economy (Fashion for Change, 2021; Todeschini et al., 2017). It requires detailed information on the involved textiles (e.g. origin, blend), which, due to lacking transparency and traceability, are not always readily available (Luján-Ornelas et al., 2020). Finally, an internal barrier for start-ups is the time-consuming nature of the technology itself. For example, in the Dutch Tomato Textile Project, Lommerse and Loots (2022) found out that the technique of turning tomato pulp into workable textile is a lengthy process, and adding to that, tomatoes can only be harvested during three months in a year. This is a relevant barrier for numerous comparable start-ups that create sustainable textiles from fruit or plant pulp.

Technological Drivers

An external driver for technological development is that emerging reverse logistic processes (for instance Patagonia's repair shops or The North Face's 'Renewed' line) increase the **need for technological solutions** for them to function effectively (Todeschini et al., 2017). On top of that, increasing efforts into recycling calls for technological innovations to **increase efficiencies and keep costs low** (Baden-Fuller & Mangematin, 2012; Ninnimäki, 2018; Turnbull et al., 2021). An internal driver for start-ups described by Todeschini et al. (2017), who explain that technological solutions can drive the scaling up of CBMs. Hence, start-ups that wish to pursue a CBM might be driven to innovate to reach their sustainability goals.

4.3.5. Social and Culture

In this section, I elaborate on the barriers and drivers on social and cultural perspectives, attitudes, norms and values towards circular innovation in fashion. Numerous authors whose work was reviewed described

how many consumers and industry players are unaware of the negative impacts of the fashion industry, and the concept of circularity in fashion (Baltussen, 2019; European Commission, 2019; Fashion for Change, 2021; FashNerd, 2024; Snoek, 2017; Turnbull et al., 2021). This section will delve into how that unawareness forms barriers towards CI in fashion, and what are drivers to turn it around.

Social and Cultural Barriers

The social and cultural perception of recycled materials and products currently forms a barrier (Baltussen, 2019; Ninnimäki, 2018; Turnbull et al., 2021). Baltussen (2019) found that many of the fashion start-ups she interviewed called for a necessary change of perspective towards recycled materials, as they are often thought of as 'ugly' or of lesser quality than virgin material. This perception is not only prevalent amongst consumers but is shared with many firms who don't see waste as a resource (Baltussen, 2019; European Commission, 2019). Snoek (2017) adds that the mindset of consumers towards owning versus leasing garments forms a barrier. On top of that, she argues that it is challenging to convince consumers that fast fashion is devastating for the environment. Baltussen (2019) describes how brands should make efforts towards circularity for the right reasons - many brands been accused of greenwashing, or doing the bare minimum to answer to sustainability demands of their customers.

Todeschini et al. (2017, p. 768) describe another barrier of how misaligned values within the fashion industry can block successful collaboration between CBSs and parties along the supply chain: *"Not only are there technical issues to be solved ... but misaligned organisational values can derail efforts to effectively engage in strategic partnerships. The challenge of aligning values along the supply chain extends to clients".* Finally, an internal social barrier that was identified is that start-up founders need social contacts within the industry to break into it in the first place (Snoek, 2017). I can imagine this is an especially relevant barrier for start-ups that were founded as a spin-off of university research projects, for example. Although researchers might have great contact with R&D parties, social contacts within fashion are more difficult to obtain and can hinder their access to investors, champions, mentors or customers.

Social and Cultural Drivers

As flows from the above barriers, the most impactful pull factor is increasing the consumers' awareness of the environmental impact of the fashion industry. Fortunately, consumers are becoming increasingly aware of the latter (Le Feber & Smit, 2023). (Le Feber & Smit, 2023) describe how frontrunners in circular or sustainable fashion can drive this consumer awareness by **educating the consumer on fashion's environmental impact** and steering consumers towards their solutions. This shows how active participation in stakeholder education can form an internal driver for CBSs - the more they can push for awareness around them, the more it could benefit the adoption of their CI (Luján-Ornelas et al., 2020). Turnbull et al. (2021) argue that increasing education is the only way to drive the adoption of circular solutions and technologies. However, they claim transparency and honesty regarding the information consumers receive is critical for them to make more sustainable choices. Lastly, a driver for the social and cultural acceptance of circular technologies can be found in the active participation and interaction between workers' unions and their employers. Luján-Ornelas et al. (2020) describe how this involvement is essential for fostering multi-stakeholder agreements between government, educational institutions and workers that drive the adoption of new technologies through community-focused training programs.

4.3.6. Operational & Organisational

This Section describes the operational barriers and drivers identified in the literature. Ten Napel (2024) argues there is consensus among industry players that to reach sustainability goals, collaboration across the entire supply chain is necessary. The latter is very difficult to achieve - I will delve into why this is challenging, and what other operational challenges or opportunities start-ups in fashion experience.

Operational and Organisational Barriers

Probably the most mentioned barrier is the **lack of operational infrastructure** to support the adoption of the CI (Ellen Macarthur Foundation & Circular Fibres Initiative, 2017; European Commission, 2019; Fashion for Change, 2021; Luján-Ornelas et al., 2020; Piller, 2023; Renewcell, 2023; Snoek, 2017; Turnbull et al., 2021). Not only is there a lack of supporting infrastructure, but it is highly challenging to set up one as well. These infrastructures can include the operational logistics to collect, sort, process and recycle garments, which involves many parties and is difficult to scale. For example, Turnbull et al. (2021) describes

how, for recycling, textile waste management systems are not sufficiently developed and there are not enough recycling facilities to properly recycle plastic waste from the fashion industry. In line with the lack of sufficient infrastructures to leverage the adoption of CIs, another external barrier is the **lack of suitable manufacturing or production sites** for them to test, produce or implement their CIs (Lommerse & Loots, 2022; Piller, 2023). Hence, it is crucial for CBSs to identify and collaborate with the right partners that can either offer them access to production facilities, or increase the CBS's negotiation position and help them gain access to production facilities in that way. However, it is **difficult for CBSs to find these partners** (Fashion for Change, 2021; Snoek, 2017).

Another significant barrier for start-ups in fashion is the required volume they need to order/produce with suppliers (Almanza & Van den Berg, 2016; Ballie & Woods, 2015; Baltussen, 2019; European Commission, 2019; Fashion for Change, 2021; Piller, 2023; Snoek, 2017). These **production minimums** can block the CBSs possibilities for outsourcing small-scale production, whether it be for testing or producing a small initial sample. Combined with the lack of suitable production or manufacturing sites, you can imagine it is a struggle for CBSs to find the right partners for their operational needs. On top of this, the inherently small size of start-ups makes for a weak negotiation position with suppliers. In turn, this turns into a financial barrier, since production limitations and leverage capacities cause start-ups unable to attain high margins (Almanza & Van den Berg, 2016). Snoek (2017) add to this point by finding that start-ups' weak negotiation position can force them to accept faulty products from suppliers.

Operational & Organisational Drivers

For start-ups, a driver to CI adoption is the mobilisation of members along the supply chain, as there is **power in numbers** (Snoek, 2017). Another internal driver that CBSs benefit from, is that their operations are **programmed towards circularity from the start.** This contrasts linear incumbents, whose supply chain is designed to facilitate linear production, making it more difficult for them to adopt circular solutions.

4.3.7. Information and Knowledge

The fashion industry is full of knowledge networks that facilitate the development and diffusion of knowledge on new materials, design, and production techniques. However, some authors regard a lack of knowledge as a significant barrier to the introduction of innovations in fashion (European Commission, 2019; Fashion for Change, 2021; Luján-Ornelas et al., 2020). This section delves into the barriers regarding information and knowledge, along with solutions suggested to drive the diffusion of information.

Information and Knowledge Barriers

An external barrier that effects CBSs in fashion is the lack of information and tools within knowledge networks (European Commission, 2019; Fashion for Change, 2021; Luján-Ornelas et al., 2020). Luján-Ornelas et al. (2020) argue that, for SMEs in particular, there is **very little information available,** causing smaller firms to be extra vulnerable to market changes. In their survey including 38 start-ups and SMEs, Fashion for Change (2021) found that many of them missed online platforms that provide comprehensive information on the fashion industry, circularity, potential partners, funding opportunities and other useful resources. Currently, this information is scattered, inhibiting start-ups from obtaining vital knowledge. Other than a lack of a centralised information, start-ups suffer from high degrees of secrecy within supply chains (Almanza & Van den Berg, 2016), making searching for relationships with manufacturers and retailers difficult. Internally, Snoek (2017) found that innovative **start-ups feared sharing information** regarding their technology within the industry, and experienced this as a barrier to enter the market. Not having patents for their innovations, for example, can hinder the introduction of innovations as start-ups fear their proprietary knowledge might be appropriated (Baltussen, 2019).

Another barrier is that start-ups **cannot benefit from spillover effects** coming from other entities within the innovative cluster. These benefits can include knowledge, reputational benefits, or benefits concerning the legitimacy of the technology (Lommerse & Loots, 2022). Le Feber and Smit (2023) found that especially small companies in fashion struggled to find employees with the right knowledge and skill set to implement more complex innovations. Lastly, another identified internal barrier is a lack of business acumen or knowledge about the fashion industry. Fashion for Change (2021) describe how, even though founders might have a profitable business case, they often lack the knowledge and experience to properly communicate their value propostion to potential customers and investors.

Information and Knowledge Drivers

Le Feber and Smit (2023) argue that although not a lot is known on what exact connections stimulate de adoption of innovations within the fashion industry, it is evident that **social capital** is essential. They found that, especially start-ups, value access to lectures, researchers and other entrepreneurs to exchange ideas and learn from one another (Le Feber & Smit, 2023). Within the same line of reasoning, Ellen Macarthur Foundation and Circular Fibres Initiative (2017) proposes that a major driver for technological advancement is to **mobilise 'moonshot' innovations,** where stakeholders collaborate to stimulate radical innovations within the fashion industry. More specifically, Fashion for Change (2021) argue that public-private partnerships (so-called 'Circular Acceleration Houses') are a good format to drive innovation in an interconnected community. Fashion for Change (2021, p. 23) describe that *"core functions [of these communities] include networking and matching, training and education, promotion of best practice and innovation, joint research and advocacy, as well as facilitating access to practical support tools, including business consulting and funding, accelerator and incubator programmes"*. The above emphasises how collaboration, as opposed to competition, can drive radical innovations within the fashion industry (Ten Napel, 2024).

A major internal driver for start-ups regarding knowledge generation is a **flexible, free and creative company culture**. Le Feber and Smit (2023) highlights how this collaborative culture can drive innovative ideas and align circular principles among employees. Lastly, **industry experience** is considered a driver for start-ups to navigate the hurdles of the early stages of entrepreneurship - especially the network obtained within this industry experience is highly valuable (Almanza & Van den Berg, 2016). Todeschini et al. (2017, p. 768) add that start-ups have a unique position, as *"...start-ups can use their expertise in sustainable innovation to provide consulting services, knowledge, and networking to large firms wishing to further their CSR commitment by developing their own green products and initiatives"*.

4.4. Literature Review Key Takeaways

Figure 2.3 and 2.4 show the barriers and drivers identified in the literature review, and an extensive overview of all the drivers and barriers can be found in Appendix B.3. From face value, a first observation is that quite a lot more barriers were identified than drivers: 53 versus 30, respectively. Of course, the reverse of a barrier often describes a driver, but drivers were only taken into consideration when they were explicitly mentioned as one in the literature. This disparity between barriers and drivers emphasises the need for increased attention on developing solutions and strategies for overcoming obstacles to CI introduction in fashion. Furthermore, I formulated the following key takeaways:

- Based on the reviewed literature, the key takeaway is to realise the importance of **collaboration** for the successful introduction of CIs to the fashion industry. Even if the CI is introduced by a relatively small player, such as a CBS, a mobilisation of industry players is needed to properly adopt and utilise the technology. This collaboration is relevant to numerous dynamics:
  - Collaboration is needed to obtain an **operational infrastructure** that sufficiently leverages the introduction of a CI. This infrastructure can include suppliers, recycling firms, waste collection organisations, municipalities, and consumers.
  - Collaboration is necessary for maximising the returns the fashion industry gains obtain from **knowledge development networks**. Collaboration on R&D can lead to more radical innovations, that upend the traditional ways of production and recycling in fashion. Sharing knowledge between start-ups can aid CBSs in resource mobilisation and gaining legitimacy for their technology, and reducing the secrecy within supply chains can help CBSs tailor their technology better to current production standards.
- The focus on immediate returns has to shift to **long-term investments** if we want to drive change within fashion. Innovative parties, especially start-ups, require investment parties or partners that offer them long-term support to help them develop, test, legitimise, and scale their CIs. Re:new:cell is the living example of how, even though a CBS might have developed a game-changing innovation, it is almost impossible to survive in fashion without long-term support from large industry players.

- The importance of comprehensive and harmonised **policies and regulations** cannot be understated. One way or another, all reviewed literature mentioned regulatory and policy intervention as a critical driver for systemic change within the fashion industry. Regulations can force large corporations to seek circular solutions and penalise them for not doing so. Policies can provide CBSs with financial incentives to develop and introduce their CIs. And lastly, international regulations make it easier to implement CIs that target international flows of resources, such as waste and feedstock.

- The extent of the **literature gap** there is currently in the academic literature on the introduction of eco-, green-, or circular innovations within the fashion industry. Let me elaborate:

  - Of the **53 identified barriers, 25 were coined by grey literature** and not mentioned in the academic literature. For drivers, this ratio was 10 to 30, respectively. Many of these 'additional' barriers and drivers were found as a result of interviews with start-ups in fashion. This suggests that gaining more empirical insights remains crucial in understanding how CBSs introduce CIs to fashion. Only when we know exactly how they do it now, and what difficulties they face, can we educate other industry players and policymakers on how to better support and include these innovative parties in their strategies and policies.
  - Multiple fashion CBSs I talked to at the ChangeNOW 2024 summit, acknowledge there is a **lack of attention given to technologically innovative start-ups in fashion,** whether it be in the investing, media or academic landscape - some even asked me to send them my thesis upon completion, as it would provide them with start-up-specific information they had a hard time finding themselves. Although this is only anecdotal evidence, it hopefully goes to show that the sentiment is shared amongst CBSs in fashion and researching the topic further would contribute to raising more awareness of the importance of start-ups as innovators in fashion.

Overall, this literature review sheds light on significant challenges and opportunities associated with the introduction of CIs in fashion. The disparity between the number of barriers and drivers underscores the pressing need for increased efforts to overcome obstacles to CI adoption by CBSs in fashion.

4.5. Literature Review Limitations

Although great care went into the selection and analysis of appropriate literature for this review, it is essential to identify limitations. First, not all literature specifically describes the drivers and barriers for CI introduction by CBSs in fashion. Although all papers were fashion industry-specific, some focused on entrepreneurship in fashion in general (Todeschini et al., 2017), while others described the introduction and adoption of technologies within fashion, without specifying if the identified drivers and barriers would also be relevant for start-ups (Ninnimäki, 2018; Turnbull et al., 2021). The latter implies that some barriers and drivers described in this chapter might not be especially relevant for CBSs in fashion, or that I missed out on relevant drivers and barriers for fashion CBSs - the latter might impact the **validity** of the findings from my literature review. However, I aimed to maximise the validity by:

- **Triangulation of drivers and barriers**. In Section B.1 in Appendix B, the complete overview of drivers and barriers is given with their respective sources. It can be seen that for most of the identified drivers and barriers, multiple articles mentioned them.
- **Critical assessment of each driver and barrier**. Once an article was selected for the literature review, each driver or barrier identified in the text was diligently examined to assess its relevance to CI introduction by CBSs. This examination was done by considering if the driver/barrier in question would be relevant for 1) start-ups in fashion, 2) introducing circular solutions in fashion, and 3) introducing a technological innovation in fashion.

However, even with the above measures in place, I acknowledge that potential biases might have impacted the validity of the literature review. For example, multiple publications have been excluded due to describing high-level barriers and drivers to CE adoption in fashion (de Aguiar Hugo et al., 2021; Dissanayake & Weerasinghe, 2022; Koszewska, 2018), or the focus on a specific type of entrepreneur - the impact of the latter is described in the next paragraph.

The focal **'type' of entrepreneur** for my research differs from some of the types described in the literature. Almanza and Van den Berg (2016) state that there are two types of fashion entrepreneurs: the commercial one and the designer, and many authors adhere to a similar logic (Mills, 2011; Sarkar & Mahbub Karim, 2019)[3]. However, I argue that the type of entrepreneur under investigation in my research falls into neither of those categories. I bring this up, because I believe it highlights a limitation of this literature search: although all papers focused on the fashion industry, start-ups can have wildly different orientations (design, commercial, technological), which can dictate which barriers and drivers are identified and deemed relevant, and hence the **generalisability** of the findings from my literature review. In summary, the findings of my literature review may not be universally applicable to all start-ups in the fashion industry due to variations in entrepreneurial types and business orientations.

Lastly, I want to touch upon the **reliability** of my literature review. First of all, I could have missed crucial barriers and drivers by excluding or not knowing of certain publications that would have been valuable. However, I tried to minimise this reliability limitation by 1) extending my literature search to **include grey literature** as well as academic literature, 2) performing **multiple rounds of literature search,** including significant snowballing efforts, and 3) reaching **thematic saturation** within this literature review. I eventually found that additional literature did not add to the list of drivers and barriers.

Next Steps

In this Chapter, I have procured a list of barriers and drivers potentially applicable to CBSs introducing their CI to the fashion industry. Although this list provides a good starting point for analysing what drives and inhibits CBSs from introducing CIs, they are not guaranteed to fit the drivers and barriers the CBSs within my case studies encounter within the empirical context of the French fashion industry. On top of that, a list of barriers and drivers is a rather 'static' and one-dimensional approach. Within a TIS approach, outlined in Chapter 2, we are more interested in **dynamic processes that shape innovation**. This way, drivers and barriers can be put into context and viewed within the processes and interactions that CBSs partake in. This, in turn, provides a good stepping stone to identify inducement or blocking mechanisms CBSs endure. The above is what I have done, and the results of this analysis are presented in Chapter 5.

[3] Note that these two publications are not included in my literature review, but aim to show how fashion entrepreneurs are often categorised as either designers or commercially driven.

05 Results

Contents of this Chapter

An overview the French fashion industry: networks, regulations and circularity

Figure 5.0 A visual on the positioning and connectedness of the case study CBSs within the textile and fashion value chain

5.1 Strategies and Value Propositions for CI Introduction

5.2 Drivers & Barriers: Empirical & Literature Review

5.3 TIS, Drivers and Barriers: a Cross-Case Analysis

5.4 Inducement and Blocking Mechanisms

5.5 The Results from an Abductive Approach

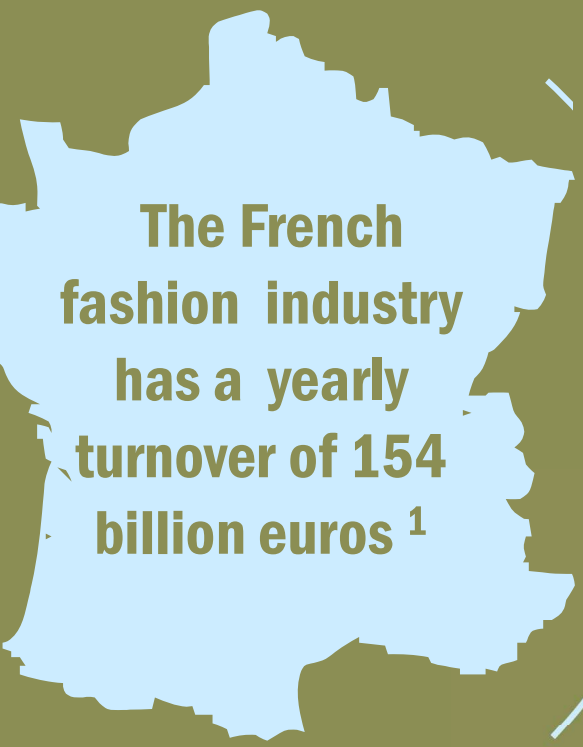
How to read this Chapter?

Before you delve into the results presented in this Chapter, I recommend to read the **overview of the French fashion industry,** presented in the next two pages. This will familiarise you with a number of organisations, regulations and agencies that are referred to frequently in the results. After, it will help to review the visual overview of how the **CBSs are positioned in the fashion & textiles supply chain.** This will help you understand the operations of CBSs, and why certain CBSs encounter challenges that others don't, for example. Lastly, I suggest you have the **Case Report** on hand. It contains in-depth information on each separate case, hence providing more background information and storytelling on what activities and interactions the CBS in quesion engaged in to introduce their CI to the fashion industry.

Please note that due to the frequent occurance of **interview quotes** from the semi-structured interviews, the choice was made to only include references when a non-interview quote is used. Hence, quotes within the results are from the semi-structured interviews with CBSs, unless explicitely referenced otherwise.

L'industrie de la Mode en France

en quelques mots



1

30% of the global fashion market is in the hands of the **French luxury Maisons**, such as Louis Vuitton, Hèrmes, Dior and Chanel. Paris in particular is considered the global epicentre of fashion [1]

2

Other than fashion's strong cultural heritage, the industry is a major economic force in France. It represents **3.1% of France's GDP**, which is more than the automotive industry [1]

1. Source: Choose Paris Region (2024)

3

France is home to many **historical textile regions,** such as Vosges, Alsace and Auvergne. France is also Europe's largest producer of flax a fibre used to produce linen (Alliance for European Flax-Linen & Hemp, 2024)

Some ecosystem associations you should know

FASHION GREEN HUB

Since its creation in Roubaix in 2015, the **Fashion Green Hub** has grown to have over 530 members. They strive for collective solutions for more sustainable and ethical fashion, and manage multiple third-party locations where innovators can interact. Each year, they organise the Fashion Green Days and the Fashion Tech Days in France. (Fashion Green Hub, 2024)

Re_fashion

Refashion is the textiles, household linen and footwear **eco-organisation.** Refashion plays a vital role in preventing waste by, e.g., providing recycling firms with textile/shoe waste and connecting stakeholders along the supply chain. Refashion also provides tools, services and information to accelerate the transition to a CE. The **Repair Bonus,** a financial compensation for consumer repairs, is an initiative from Refashion (Refashion, 2024).

FÉDÉRATION de la MODE CIRCULAIRE

The **Féderation de la Mode Circulaire** was launched in 2022, and is a professional organisation that represents circular actors in fashion. With more than 250 members, they help members develop, and and promotes transparency and awareness (Féderation de La Mode Circulaire, 2024)

PARIS GOOD fashion

Paris Good Fashion defines itself as a **lab for co-creation**. It is a Paris-based association for connecting NGOs, designers, companies and other innovators to develop concrete and practical solutions to accelerate the transition to a sustainable fashion industry. Their work includes a glossary for circularity-related terminoligy in fashion (Paris Good Fashion, 2024).

Laws and Regulations

FUNDS DPP AGEC

In 2020 France introduced the AGEC law, which translates to the '**Anti-Waste for the Circular Economy**' law. The law requires brands to provide their goods with environmental labels that provide transparent information on product content and origin. prohibits the destruction of dead stock (unsold goods) and requires brands to be transparent on the environmental impact of their products. Brands with a turnover over €50 million were to comply from January 2023, while smaller brands will be held accountable in the coming years (Sustainable BrandPlatform, 2023) The AGEC framework additionally presents a **2023-2028 roadmap** specific for the textile sector, which aims for better collection, recycling and repair practices (République Française, 2024).

In April 2024, the European Parliament announced the revised **Ecodesign Framework**. The Framework outlines sustainability-related requirements on all products sold in the EU, with garments and footwear being a priotity product category. To better inform consumers in their purchasing decisions, the **Digital Product Passport** (DPP) is suggested. Each product will have a unique digital identity, a DPP, which is managed through a web portal that consumers can access to review and compare information (European Parliament, 2024).

ADEME is a public French Environment and Energy Management Agency. ADEME is the point of reference for citizens and companies for preserving the environment. Other than mobilising stakeholders, ADEME is a source of funding for innovative projects. ADEME relies on the **France 2030 plan,** a €54 billion investment plan, geared to support innovations that help France meet ecological, economic and industrial challenges. It is used to support companies, universities and research institutes to transform sectors sustainably (Agence de la transition écologique, 2024).

La Mode Circulaire en France

Accoring to a market study by Accenture and the Féderation de la Mode Circulaire, circular models currently represent about **€5.7 billion** in France. This is mainly driven by political changes, the arrival of new entrants and the positioning of historical actors. They expect the growth of circular initiatives to continue, expecting circular models could reach a market of **€14 billion by 2030,** 29% of the French luxury fashion market. This growth is mainly driven by reuse, but repair is expected to become increasingly mainstream (Accenture, 2024). **Collection capacities** are expected to double, and the volume of recycled textile products could triple by 2030. The environmental impact of circular models in general is estimated to reduce the industry's **CO2 emmissions by 16% (**Accenture, 2024).

In 2021, **La Caserne** opened its doors in Paris. It is the largest **sustainable fashion hub** in Europe, and currently incubates more than 9 sustainable fashion brands and start-ups (La Caserne, 2024).

The Fashion and Textile Supply Chain and the positioning of the 9 CBSs

Figure 5.0 An overview of the positions of each CBS within the fashion supply chain. Arrows are colour-coded according to their material flow type (regular flow or closing, slowing or narrowing loops). The visualisation is best navigated by starting at the 'Fibre Spinning', and working through the outermost loop by following the arrows. In subsequent iterations, inner loops (e.g. Care & Repair) can be explored.

Begin here

iNDUO conducts research on all stages of production: spinning, weaving, knitting and finishing. They have created an **innovative material** that is stain, sweat and wrinkle proof, reducing the need to wash and iron garments made from their fabrics (iNDUO, 2024)

Fibre Spinning → **Weaving & Knitting**

ever dye

EverDye has eveloped an innovative, **non-toxic dyeing process** that reduces emmissions by 10 fold (EverDye, 2023)

→ **Dyeing**

Iroony©

RBX Créations have developed Iroony, a **sustainable material** based on an innovative process to extract the **cellulose** from hemp stalks. These are byproducts from the food and agriculture industry, which can be made into fibres and packaging (Iroony, 2020)

Byproducts from the food and agriculture industry

THE 8 IMPACT, Refact and Recyc'ELIT's processes include both mechanical and chemical recycling

THE 8 IMPACT

THE 8 IMPACT uses both mechanical and chemical recycling methods to **recover rubber** from used shoes.

Depending on the rubber content of the shoes, they are shredded, ground, or chemically recycled to recover the raw materials with high purity rates (THE 8 IMPACT, 2021)

Recycling - Mechanical

Refact

Refact by iNDUO has developed a recycling technology in which textiles are first shredded and ground (mechanical), after which **viscose** is obtained from a chemical process (Refact, 2023)

Open Loop Recycling

Recycling - Chemical

RecycELIt

Recyc'ELIT shreds textile waste before introducing their patented formulation according in which PET parts are depolymerised. After, the monomers of PET are purified and **virgin resin** can be manufactured (Recyc'ELIT, 2021)

Legend

- Usual material flow
- Closing resource loops
- Slowing resource loops
- Narrowing resource loops
- Data flow

itmatters

Itmatters' washable **smart tags** are integrated into garments and shoes during manufacturing, and combined with a digital 4.0 platform, allows brands to track their goods during their lifecycle (itmatters, 2021)

Brands

Clothing manufacturing

Retail

Pre-consumer waste (deadstock)

WETURN

Weturn facilitates the valorisation of deadstock. Textiles are either **reused, resold, or recycled** into new fabrics. Their digital tool, **VALO,** allows brands to track their material flows (Weturn, 2024)

Weturn's sorting method

PROLONG

PROLONG has built an **omni-channel SaaS platform** that allows brands to streamline their care & repair operations. They don't do repairs themselves, but link brands to care & repair experts through their platform (PROLONG, 2024)

Repair & Care

Use

Resale

Reuse or donation

[RE] PAIRE offers shoe brands, and soon textile brands, a digital, white brand turnkey solution to enter the care & repair system. They take over **the logistics and repairs** and developed a **digital platform** that allows customers and shops to demand a repair request ([RE] PAIRE, 2024)

Post-consumer waste

Collection & Sorting

LE RELAIS

Re_fashion

Sorting centres, such as Le Relais, are **essential links** in the recovery chain: textiles and shoes are sorted according to the accreditation specifications set by eco-organisations, e.g. Refashion (Refashion, 2021)

Landfill or Incineration

In the Fashion & Textile Industry ...

SQ1 **How do CBSs position their CIs in terms of circular strategy and value proposition?** **Section 5.1**

Section 5.1 presents the strategies employed by CBSs when introducing their CIs within the fashion and textile industry. First, I explore both the overarching strategies utilised by CBSs, and then I will delve into the specific value propositions they offer to brands, customers or other industry stakeholders. Analysing these aspects provides us with valuable insights into the approaches adopted by CBSs to drive sustainability and circularity within fashion, and allows us to answer SQ1.

SQ2 **How do processes and interactions shape the market introduction of CIs by CBSs?** **Section 5.3**

Understanding the positioning of CIs and CBSs is not enough to understand *how* CBSs introduce their CIs to the fashion industry. To further understand what actions they undertake during market introduction of their CIs, Section 5.3 presents the results that identify and describe the processes and interactions CBSs engage in. Relevant drivers and barriers are linked to processes and interactions (the drivers and barriers discussed in Section 5.2) to obtain a complete understanding of how these processes and interactions shape CI market introduction.

SQ3 **What factors drive or hinder the introduction of CIs by CBSs?** **Section 5.4**

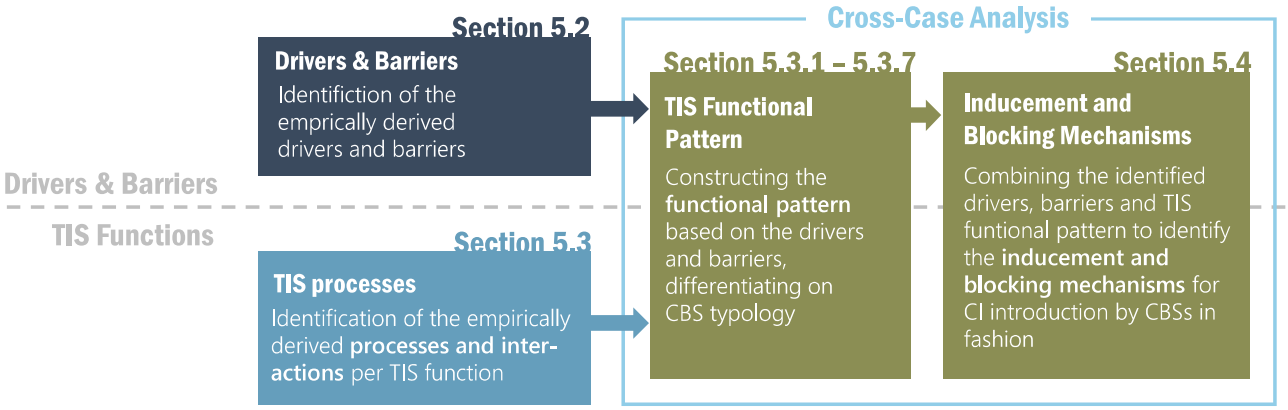
As a result of answering SQ2, we have a rich understanding of what drivers and barriers, along with what processes and interactions CBSs experience when introducing their CI. In Section 5.4, the main influences that hinder or block CI market introduction can be identified, therefore answering SQ3. Section 5.4 provides both the analytical approach followed to identify these inducement and blocking mechanisms, along with the results.

05 Results

This Chapter discusses the results of this research, based on the case data gathered across the 9 cases I conducted. In the supplementary document, the **Case Report**, you will find the descriptive cases of each CBS. While this Chapter highlights the results from all the cases together and between the cases (cross-case), the Case Report explains the process of market introduction for each CBS separately - the latter is written to provide background information, and to ensure no valuable primary data is lost. To gain a better, in-depth understanding of each case on its own, it is beneficial to read the Case Report.

In Section 5.1, I will present the results related to SQ1: *With what circular strategies and value propositions do CBSs use to introduce their CI to the fashion and textile industry?* Figure 5.1 outlines the structure for Sections 5.2 to 5.3, corresponding to SQ2 and SQ3. To answer SQ2 and SQ3, two lines of analysis were followed: identifying drivers and barriers CBSs face, and identifying the processes and interactions they partake in. Figure 5.1 illustrates these lines: the top half focuses on drivers and barriers, and the bottom half on TIS functions. The blocks spanning both halves combine these analyses.

Figure 5.1: A visual overview of the structure of the results related to the TIS functions and the drivers and barriers, paired with the section in which the in-depth analysis can be found.



First, drivers, barriers, processes, and interactions were identified separately in Sections 5.2 and 5.3. Then, the findings are combined to establish a functional TIS pattern in which empirical connections between key innovation functions and the drivers and barriers that CBSs encounter in their technology innovation and diffusion efforts are made (Gruenhagen et al., 2022) - presented in the remainder of Section 5.3. From this, inducement and blocking mechanisms are derived in Section 5.4. Finally, Section 5.5 discusses results related to any changes or redirections in the research due to the abductive approach.

5.1. Strategies and Value Propositions for CI Introduction

In this section, I present the strategies employed by CBSs when introducing their CIs within the fashion industry. First, I explore both the **overarching strategies** utilised by CBSs, and then I will delve into the specific **value propositions** they offer to brands, customers or other industry stakeholders. Analysing these aspects provides us with valuable insights into the approaches adopted by CBSs to drive sustainability and circularity within fashion.

5.1.1. Circular Strategies

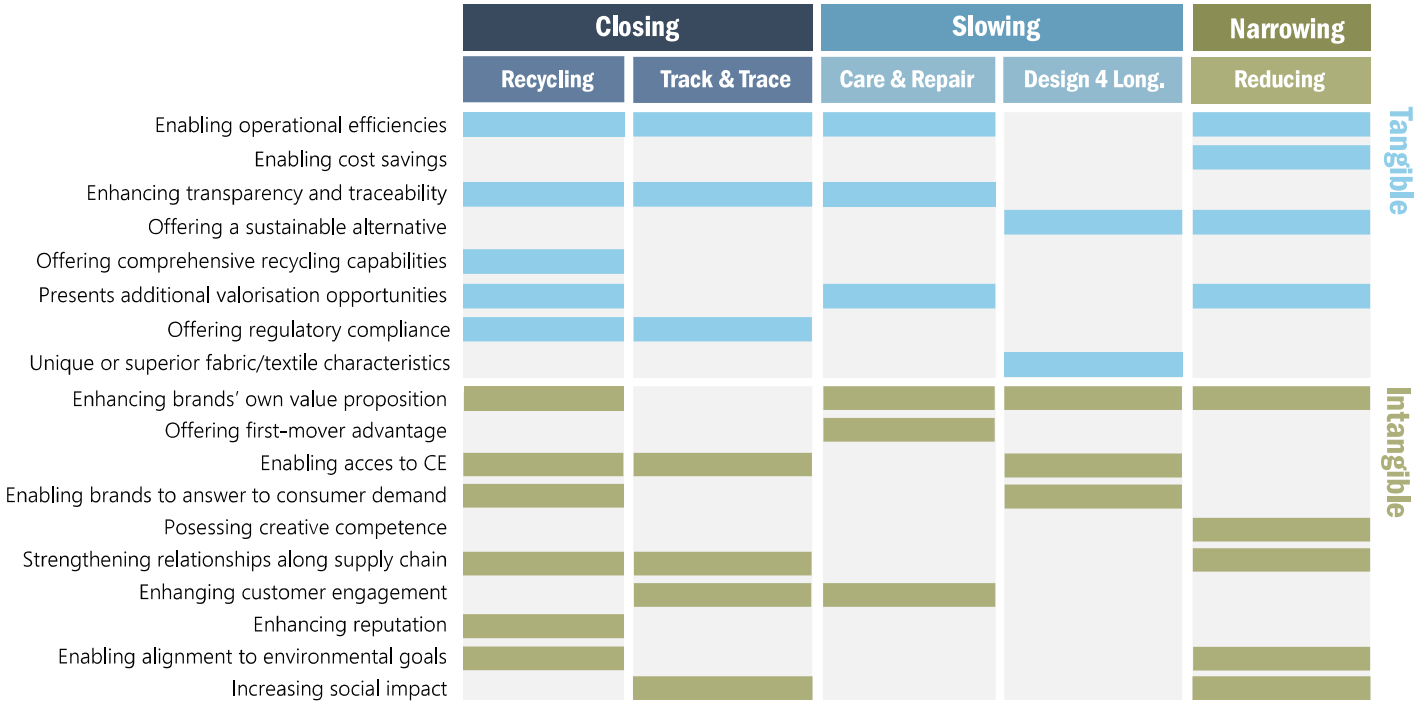
Across the 9 CBSs included in this research, 8 clearly pursued either a closing, slowing or narrowing **circular strategy** according to the approaches (recycling, reducing etc.) defined in the fashion CI framework, presented in Table 2.1. There are two empirical findings that add to the above: first, it is possible for a CBS to pursue multiple circular strategies if they have multiple CIs (iNDUO®, for example). Second, when a CI falls under the circular approach of design for durability/recyclability/etc., all three circular strategies are relevant and must be actively taken into consideration. A circular garment or textile must be made to ensure it can be produced sustainably and contains sustainable materials (narrowing), it must be made to facilitate easy repairs (slowing), and must be designed such that it is recyclable at its end of life.

Going a level deeper than the circular strategies, each CBS has a distinct **circular approach**. The CBSs in my research primarily position themselves according to their specific circular approach, rather than the overarching circular strategy. This provides clarity on their processes or products and aligns them with project calls and regional, national, or EU initiatives. Within the industry, communication about CBS type/description takes place at this level of granularity - the latter was confirmed in my expert interviews, who both used the circular approaches to distinguish and describe CBSs.

5.1.2. Value Propositions

Other than the circular strategies mentioned above, the CBSs within my case study are all vocal about their added value. This does not come as a surprise, as 5 out of 9 CBSs explicitly mentioned that it's essential they know, and are able to communicate, the added value of their CI. EverDye emphasises that *"we contact brands to present our product, especially what the advantages [are] of our product...it's all about these advantages"*. Although the CBSs included in this research are all highly different, I found similar elements in their value propositions. Figure 5.2 shows a visual overview of the tangible and intangible benefits that CBSs have put forward as a way to position their CIs.

Figure 5.2: A visualised overview of the tangible and intangible value propositional aspects that CBSs communicate about their CI.



Note that for Figure 5.2, only information from the CBs' websites was used to ensure those benefits were taken into account that the CBS promotes their CI with. The top half of the Figure shows tangible benefits, while the bottom half lists the intangible benefits. Based on Figure 5.2, I will briefly discuss the most interesting findings we can draw, both the tangible and intangible value propositional aspects.

Tangible Benefits

CBSs across all circular strategies emphasise the benefits of operational or cost efficiencies and additional valorisation opportunities. Unique benefits for closing CBSs included regulatory compliance and enhanced traceability and transparency, which can be explained by considering that within closing resource loops, these aspects are critical for ensuring that materials are effectively reused or recycled in compliance with legal standards. Enhanced traceability and transparency facilitate the monitoring of material flows, ensuring that resources are not wasted and are reintroduced into the production cycle. Both slowing and closing CBSs highlight the benefit of enabling brands to enter the CE, especially through solutions that simplify reverse logistics. Narrowing and closing CBSs emphasise better alignment with environmental goals. Notably, Care & Repair CBSs do not highlight specific environmental benefits, likely due to the difficulty in measuring impacts that are highly dependent on consumer behaviour.

Intangible Benefits

CBSs belonging to all circular strategies mention that their CIs can enhance the value proposition of brands, demonstrating how these solutions improve the brands' offerings, such as repair services, recycled fabrics, and sustainable alternatives. Care & Repair CBSs uniquely promise industry leadership and first-mover advantage in the CE, hence positioning themselves as pioneers in the market. CBSs with digital consumer interaction emphasise enhanced customer engagement, by providing brands with consumer behaviour insights and more digital touchpoints for consumers.

The above summarises the information from Figure 5.2. However, looking at the Figure, there are some more high-level takeaways we can formulate:

- CBSs across all circular strategies focus on **both tangible and intangible benefits**. It is important to realise that just because a CBS does not explicitly mention any of the value propositional aspects described above, it does not mean they are not applicable to their CI - however, it provides us information on what communication they believe to attract the most interest from.
- Whatever the combination of benefits, the analysis above shows that all CBSs position their CI in such a way that its added value **extends beyond providing clients entry into the CE,** and their CI should be attractive from multiple perspectives to present themselves as an attractive solution.
- As the Figure shows, **no strict lines can be drawn** between which benefits belong to value propositions under specific circular strategies. Often, distinctions need to be made based on the CBS's circular approach, their role in the supply chain, or their specific product to properly understand why certain benefits are or are not included in their value proposition.

5.2. Drivers & Barriers: Empirical & Literature Review

Chapter 4 presents the literature review on the drivers and barriers CBSs experience when introducing CIs to the fashion industry. In this Section, I will present how these drivers and barriers compare to the ones I identified empirically. For this, I conducted **pattern matching**. To pay respects to my Scottish heritage, the **tartan** was the obvious pattern of choice. **Tables 5.1 and 5.2** serve as an example of the pattern matching that was carried out, presented on blue tartan. The drivers and barriers that were identified solely in the literature but were not identified empirically are shown in the left column of the tartan, under 'literature only'. When a driver or barrier from the literature matched with a driver or barrier that was empirically identified, it is shown in the middle column under 'match'. In this column, a single, frequently mentioned barrier or driver is given as an example - an overview of the entire pattern matching analysis can be found in Appendix B.3. Lastly, the right column shows quotes from the case study data that prove as evidence for the driver or barrier shown in the middle column.

In total, **96 drivers and 89 barriers were identified in this research**, and 30 and 56 were found in the literature. This discrepancy in volume can be attributed to the following reasons: first, a number of the empirical drivers and barriers are specific to the empirical context of this research. For example, the driver 'proximity to historical textile regions' is very relevant in France, but might be less relevant in other countries. Secondly, some empirically derived drivers and barriers 'explain' more general drivers and barriers identified in the literature. So, for example, 'the fashion industry is slow to respond to the CE', can be explained by a plethora of other barriers. I will go into more detail on these cases in the next to subsections.

Both the selected literature and this research have in common that the start-ups/technologies/innovations in question vary considerably. Turnbull et al. (2021) delve into recycling technologies, while Lommerse and Loots (2022) examine an innovative process to make textiles out of tomato pulp. Although this heterogeneity is great for casting a wide net when searching for drivers and barriers, it is less suitable for deciding on a specific set of drivers/barriers for one single CBS. So, I am not going to do that. However, I am interested in pinpointing the **drivers and barriers that are mentioned in almost all cases**. Hence, my analysis will also include the most universal drivers and barriers. Lastly, I will briefly touch upon any drivers and/or barriers I found that **contradict** what I found in the literature.

5.2.1. Drivers

In Chapter 4, I identified 30 unique drivers within the selected literature. Within the case studies, I identified 96 drivers. The **complete list of empirically identified drivers** can be found in Section B.2.1 in Appendix B. For 22 of the drivers from the literature review, an (almost) exact match was found with the empirically derived drivers. The 8 drivers which did not match with my empirically derived drivers are shown in the left column of the tartan in Table 5.1. That leaves 74 empirical drivers to have no match with the literature. For the drivers, this discrepancy is explained by the following:

- 16 of the drivers I identified highlighted the positive effect **brand- or industrial collaborations** have when introducing an innovation to the fashion industry. Although acknowledged in the literature, the mentioned benefits were of limited granularity. Drivers stemming from brand collaborations include access to machinery/industrial facilities (*"They'll [industrial partners] help you, and you have access to the machineries"*, EverDye), enhanced marketing (*"[the ETAM group] support us to market our solution"*, (WeDareLab by Etam Groupe, 2023)), access to industry specific information (*"we can ask brands to give us the criteria that they are looking for"*, EverDye), being pushed to create a development roadmap (*"[brand] helps us make the roadmap for the coming years"*, (La Seconde Vintage, 2024b)), and getting to know the materials and processes brands work with (*"at the beginning we were doing it [sorting and recycling shoes from brands] almost by hand..., each time seeing, OK, what's in here?"*, THE 8 IMPACT). On top of that, brands can catalyse action in their supply chain (*"so this prescriptor [brand] would act on all the value chain to tell them, I want to work with this start-up"*, Recyc'ELIT) and can open up a CBS's network to their partners and customers (*"so it's partners that our customers bring to us that we'll pool together"*, (La Seconde Vintage, 2024b)).

- 5 drivers were identified during this research regarding the importance of **ecosystem associations**, that were less present in the literature. Drivers regarding these associations included increased visibility (*"that's quite a nice opportunity [being member of ecosystem association] to get involved, get great visibility"*, Weturn), the ability to received feedback/assessment on the innovation (*"Fashion for Good actually assessed our solution and traceability innovation tools"*, itmatters), receiving strategic advice (*"they [ecosystem associations] have more knowledge about the big strategic issues in the world right now"*, EverDye), and assisting the CBS in securing (free) textile waste feedstock - THE 8 IMPACT explains that Refashion *"can even do an over-sort and just send us back what we can recycle"*.

- For most of the CBSs in this research, the **region** played a very important role in the introduction and industrialisation of their innovation. This was in lesser extent present within the drivers I found in the literature. Drivers related to regional engagement were increased visibility (*"the metropolitan is doing a lot for us, try to make visibility for us"*, Recyc'ELIT) and enhanced access to EU markets and funding (*"[the region] facilitated access to two European financing programs in the textile field"*, ADI Nouvelle-Aquitaine (2022)). In total, 6 drivers related to partnerships with the region were identified.

Most Prominent Drivers

By far the most mentioned driver for the introduction of CIs in fashion is emerging **regulations**, forcing brands and retailers to *"find a solution for what they are putting on the market"* (Recyc'ELIT) - it was mentioned in all reviewed literature and in each case. Regulations pressure brands to collaborate with innovative parties, and national policies can open up public financing for circular projects in the textile industry (e.g. France 2030). Furthermore, a prominent driver was the growing **awareness** of the CE and how collaborations drive **co-creation.**

LITERATURE ONLY	MATCH Drivers	CASE STUDY QUOTES
Technological		
Innovations can **scale business** (Todeschini et al., 2017) **Growing competition** in recycling pushes innovation for efficiencies (Baltussen, 2019; Ninnimäki, 2018; Turnbull et al, 2021)	Emerging reverse logistics and traceability requirements stimulate the integration of **digital technologies** (Todeschini et al., 2017)	*"brands are somehow now discovering the power of efficiency of what we call digital transformation"* itmatters
Financial		
Tax benefits for circular solutions (Fashion for Change, 2021)	Potential **incentives** for CE businesses, pooled financial support (Baltussen, 2019; Eur. Comm., 2019; Lommerse er al., 2022; Ten Napel, 2024)	*"they [ecosystem associations] have some R&D budgets that they can allocate to support R&D for some start-ups"* THE 8 IMPACT
Inform. & Knowl.		
Start-ups **open culture** stimulates sharing of information, enhances knowledge development (Le Feber and Smit, 2023; European Commission, 2019)	Engaging with other parties enables **co-creation** (Fashion for Change, 2021; Le Feber, 2023; Ballie and Woods, 2015; European Commission, 2019)	*"[we] forged 'product co-build' alliances with three innovative brands, paving our entry into the marketplace"* Prolong, LinkedIn post (2024)
Market & Economy		
Circular innovations can lead to **competitive advantage** (Le Feber and Smit, 2023; European Commission, 2019)	**Knowing impact and value** of innovation enhances ability to position it in the market (Le Feber and Smit, 2023)	*"you have to show the customer that you provide a solution"* Weturn & *"its about how much impact you can save"* THE 8 IMPACT
Regulatory & Policy		
Sustainability/eco-labels create **demand** for CE solutions (Fashion for Change, 2021; Luján-Ornelas at al., 2020)	Regulations can force organsiations to **seek circular solutions** (all LR sources)	*"most of the regulations that are happening, are strenghtening what brands need to do"* EverDye
Social & Societal		
Growing **acceptance** of recycled materials (Turnbull et al., 2021; Baltussen, 2019) and growing **awareness** for environmental and ethical issues of fashion (Snoek, 2017; Baltussen, 2019; Piller, 2023; Le Feber and Smit, 2023; European Commission, 2019;)	**Growing interest** in CE (Ninnimäki, 2018; Turnbull et al., 2021; Le Feber and Smit, 2023; Piller, 2023; Baltussen, 2019)	*"so the motivation of the brands is, we might use the use phase as something to make the people come back to the shops"* [RE] PAIRE
Operational & Org.		
Start-ups have internal operations **programmed towards CE** from the start (Snoek, 2017; European Commission, 2019)	**Personalised support** for IP strategy, strategic advice or community training (Luján-Ornelas et al., 2020)	*"so this is very great because ...we did training with them [regional INPI Agency], a master class on IP, with personalised training sessions"* Iroony

Table 5.1 Table showing examples of the pattern matching carried out between the drivers found in the literature against the drivers empirically identified. The left column shows drivers mentioned in the literature only, not mentioned within my case studies. The middle column shows one example of a driver identified in the literature, that was also identified in my research. The right column shows evidence from the case studies that confirm the driver in the middle column was identified.

Two drivers in particular were frequently mentioned within this research, but were not frequently touched upon in the literature. Firstly, start-ups have **unique knowledge** within their 'realm' of circularity, and are often consulted for panel discussions, committees, to advise brands and sometimes even policy making. THE 8 IMPACT explains it's *"as if I was doing some consulting actually"*. Itmatters is *"an expert in any market"* regarding their knowledge on DPP technology, and [RE] PAIRE tells that *"they're [Féderation de la Mode Circulaire and the Galerie de Lafayette] organising a table ronde and I will be part of one"*. This driver was only mentioned by Todeschini et al. (2017), but it has proven to be a very relevant driver for the CBSs within this research since **information on how to enter the CE is limited** for brands: *"they [brands] want to enter in this system [the CE], but they have no information on how to enter it, as well as on the price"*, explains [RE] PAIRE. Secondly, 5 out of 9 CBSs I interviewed mentioned the importance of building **demonstrators or prototypes.** They mentioned that showing brands a garment made of an innovative fabric or showing them the process in-person greatly aided in the brands' trust in their technology.

Contradicting Drivers

A driver coined by European Commission (2019) and Snoek (2017) explained how **CBSs' internal processes** are geared towards the CE from the start, as opposed to linear incumbents, which makes adapting a circular process easier. However, this contradicts a barrier I found, namely that CBSs express how challenging it is to construct non-existent processes within their company. Weturn expresses in a podcast how *"everything has got be created and processes are, at first, non-existent"* (Visconti Partners, 2023), and EverDye emphasises how *"as you go from R&D start-up to industrial start-up, you need to change all your internal processes"*. So although it might be true that processes are created to be circular, it is not perceived as a driver, but rather a barrier within my case studies.

Another driver from the literature that contradicts a barrier I found was coined by Baltussen (2019), Ninnimäki (2018), and Turnbull et al. (2021), who argue that growing competition in recycling pushes firms to **innovate to keep costs low.** Although this might be true in some cases, I found that this was not a strong driver in my cases - it was not mentioned amongst the recycling CBSs within this research. As an example, take the currently time-consuming and expensive manual sorting at textile sorting centres. When itmatters approached textile sorting centres for a pilot with their smart tag technology, which would save significant time, money and manpower, the sorting centres were unwilling to cooperate as *"actual textile collectors will be ready to integrate RFID technology only if [apparel and footwear] brands, such as Decathlon, move to adopt RFID and ultra high frequency washable smart tags"*.

5.2.2. Barriers

Within my literature review, 54 barriers were identified. In my case study, I found 89 barriers. For an overview of all literature review and empirical barriers, please refer to Sections 4.3 and B.2.2 in Appendix A, respectively. As for the drivers, the columns within the tartan in **Table 5.2** show the barriers that were only mentioned in the literature (left column) and in both the literature and this research (middle column). From the 54 barriers from the literature review, **45 directly matched** with the empirically derived barriers. The 9 barriers from the literature review that did not match can be seen in the left column of the tartan. 44 empirical barriers had no direct match with the barriers from the literature review - the following themes resulted in various barriers within my cases, that were less present in the literature:

- It is no secret that the **fashion industry is slow to respond to the CE.** Within the empirically derived barriers, I identified 9 barriers that 'explain' the somewhat glacial pace of the industry's response. First, decision-making processes within brands are long (*"I know it will take them like a year or two before they decide to actually launch the project"*, Prolong), and 5 CBSs expressed it was extremely difficult for them to get meetings with brands. Weturn said in a podcast that *"what's very complicated when you're starting out is getting meetings with the right people, the decision-makers"* (Visconti Partners, 2023) and Iroony® recalls how *"a meeting with one brand can lead to another a year later"*. Then, once you managed to get a meeting with a brand, it is often left up to the CBS to contact and convince all separate departments within the brand to adopt their solution - itmatters explains that *"we are coming from...a linear business model industry. And when it comes to linearity, everybody is focusing on his own task. And somehow they don't want to look at their colleagues tasks...so it's a huge constraint"*.

LITERATURE ONLY	MATCH Barriers	CASE STUDY QUOTES
Technological		
The duration of the **technological process** in itself can be lenghtly (Le Feber and Smit, 2023; Lommerse and Loots, 2022)	Delivering **consistent quality** with technology (Baltussen, 2019; Fashion for Change, 2021; Lommerse and Loots, 2022; and Turnbull et al., 2021)	*"Difficult to develop a colour and make them stable"* EverDye
Financial		
Economic feasibility of scaling up low (Baltussen, 2019; European Commission, 2019; Fashion for Change, 2021)	Challenging to build **profitable business model/strong business** case for CI (Ballie and Woods, 2015; Lommerse and Loots, 2022; Snoek, 2017)	*"There is very, very little margin"* [RE] PAIRE
Innovations can have **high CAPEX** (Almanza and Hendrik van den Berg, 2016; Baltussen, 2019; FashNerd, 2024; Snoek, 2017; Ten Napel, 2024)		*"...obviously you have to find your business model, we are not an NGO, we need to earn money"* THE 8 IMPACT
Inform. & Knowl.		
Fear of sharing **proprietary knowledge** due to IP concerns (Baltussen, 2019; and Snoek, 2017)	**Social capital** (expertise, knowledge, experience) hard to obtain (Almanza and Hendrik van den Berg, 2016; FashNerd, 2024; Piller, 2023; and Snoek, 2017)	*"There aren't many dyeing engineers in France anymore"* EverDye
Market & Economy		
Defensive investment strategies from brands (Almanza and Hendrik van den Berg, 2016; and Snoek, 2017)	Price for consumers often **higher for circular products** (Almanza and Hendrik van den Berg, 2016; Baltussen, 2019; European Commission, 2019; Fashion for Change, 2021; Piller, 2023; and Turnbull et al., 2021)	*"However, the price point for our solution today is way too expensive for them [smaller brands] for their need"* Prolong
Increased competition for recycling solutions (European Commission, 2019; Ninnimäki, 2018)		
Regulatory & Policy		
	Lack of **harmonised regulations** (Ellen Mac. Fndt. and Circular Fibres Initiative, 2017; European Commission, 2019; Fashion for Change, 2021; Luján-Ornelas et al., 2020; Piller, 2023; Snoek, 2017; Ten Napel, 2024; Turnbull et al., 2021)	*"There are laws which are different from one country to another, it's not always the same"* itmatters
Social & Societal		
Many businesses don't see **waste as a resource** (Baltussen, 2019; European Commission, 2019)	**CE unawareness** amongst consumers and brands (Baltussen, 2019; Eur. Comm, 2019; Fashion for Change, 2021; FashNerd, 2024; Snoek, 2017; Turnbull et al., 2021)	*"I have a problem which is, ...[there is] something under warranty, but no one knows that"* [RE] PAIRE
Operational & Org.		
Challenging to create **visibility** amongst consumers and stakeholders (Almanza and Hendrik van den Berg, 2016; and European Commission, 2019)	**Traceability and transparency** along value/supply chain needed to properly implement CI (Almanza and Hendrik van den Berg, 2016; European Commission, 2019)	*"We have this main problem...for middle brands that don't map their flows...so they don't know exactly where the fabric is from"* Weturn
Finding **right partners** is difficult (Fashion for Change, 2021; and Snoek, 2017)		

Table 5.2 Table showing examples of the pattern matching carried out between the barriers found in the literature against the barriers empirically identified. The left column shows barriers mentioned in the literature only, not mentioned within my case studies. The middle column shows one example of a barrier identified in the literature, that was also identified in my research. The right column shows evidence from the case studies that confirm the barrier in the middle column was identified.

- Another branch of barriers is related to the time- and resource-consuming **implementation of innovations** within a brand or firms, for which I identified 7 barriers. First of all, multiple CBSs expressed how it takes up a lot of time to adapt their innovation to the different IT ecosystems and workflows amongst brands. Prolong elaborates how *"their [brands'] IT ecosystems is super [different]...so integration is a big topic, and the care and repair workflow will always be different"*. Implementing the solution itself was said to be a slow, step-by-step process (*"the challenge is to help them step by step"*, Weturn), and it being a challenge to familiarise oneself with these unique environments and situations quickly. Prolong explains that *"...our client, operationally, know much more than us. So we had to catch up fast with the knowledge on the repair,...supply chain, IT..."*.

- I identified 13 barriers related to **financing**. A lack of financial resources and access to financing were coined in the literature as well, but my barriers provide an additional layer of granularity. Iroony® expressed that *"there are not that many funds that are focused on fashion...even more for industrial projects"*, while Recyc'ELIT argued that *"investing in textiles today is less attractive in the eyes of certain decision-makers, than other sectors"* (WeDareLab by Etam Groupe, 2023). 4 CBSs mentioned that public funding often requires an equal contribution from the start-up itself, and how it is difficult to make the switch from public to private funding. Iroony® explains that *"the public funding are many times limited, [national subsidies often] are capped by equity"*. On top of that, the public funding landscape is complex to navigate, and the funding calls are often *"a one-shot opportunity"* (itmatters). For obtaining private investments, THE 8 IMPACT remarks in a news article how *"investors are accustomed to digital, but they don't know how to read industrial KPIs"* (Interpreneurs, 2022).

Most Dominant Barriers

Within the literature and my cases, the **lack of transparency and traceability** was the most frequently mentioned barrier. This was confirmed by all CBSs within my case study that were involved in recycling. Weturn explains that *"for us, it's an issue too, because when we recycle, we have to know the exact composition of the products"*. For shoes, it's no different. THE 8 IMPACT tells how *"the rubber manufacturers...they never give their recipes"*.

Another prominent barrier was finding a suitable **BM**. Fashion for Change (2021, p. 11) explains how *"in most linear [BMs], costs are immediately covered by revenues from a sales transaction, while many circular models require more time to get off the ground"*. Barriers that explain the difficulty of finding a suitable BM were that circular products or services often come with higher price points, but many clients remain price sensitive. 6 out of 9 CBSs mentioned that they think end consumers and/or brands are not willing to pay more for circular solutions. EverDye adds that *"it's really not easy. Once you go to South East Asia, you need to be super competitive in unit economics"*. Furthermore, CBMs need to reach scale to become profitable. Iroony® explains, *"it's not reaching a scale where we will be at an optimised economic model, so it means that it will still be costly"*. A final prominent barrier is the difficulty of **attracting skilled employees** as a CBS - EverDye explains *"there aren't many dyeing engineers in France anymore"* (France Bouge, 2024).

Contradicting Barriers

Baltussen (2019) and Snoek (2017) found that start-ups were held back in their communication and collaborations with brands due to the **fear of sharing their proprietary knowledge.** This wasn't found to be a barrier within the 9 CBSs I analysed. A possible explanation is that all CBSs (to whom it was relevant) had IP strategies in place, for which they had received personalised support from a public IP agency or IP advisors. On top of that, EverDye explains that during discussions with brands, *"you aren't going deep into technology, we are staying a bit broad. We are not discussing with chemists, just with business people"*. This difference between my empirical findings and the ones in the literature could also be attributed to cultural differences between the countries in which the different studies were conducted: one CBS told me during our interview how: *"at the beginning of the company, we wanted all clients to sign a contract about this intellectual property, right? We eventually gave up on that, because people were just like, no, I'm never going to do that. And we realised that in most brands, there is just nobody able to read that kind of contract, they're not used to that"*.

5.3. TIS, Drivers and Barriers: a Cross-Case Analysis

As outlined in the previous Section, 185 drivers and barriers were identified within the 9 cases I conducted. Although insightful, the list in itself is rather 'static'. It says little about the context in which the drivers or barriers present themselves. The seven categories (technological, financial, etc.) help to categorise barriers and drivers, but are little help in providing more context for the driver or barrier in question. That is why, in this Section, I set out to identify and describe the processes and interactions CBSs engage in, and pinpoint relevant drivers and barriers according to the process or interaction in question.

In total, 1529 text fragments across 40 documents were identified that specified a process or interaction a CBS engaged in. These documents included interview transcripts, podcast and panel discussions, as well as news segments and interviews. Each process or interaction that was mentioned by a CBS has been coded using a coding hierarchy as presented in Table 5.3. Note how all codes are **active or process codes**[1], meant to describe specific actions or activities within a larger system. The table shows the identified processes within each function of the TIS, the result of 4 rounds of coding.

Table 5.3: Examples of the process of assigning active codes to describe TIS processes and interactions within the case data

Coding Examples		
2nd Ord. Code	**1st Order Code**	**Quote from Case Data**
Entrepreneurial Experimentation	Designing/improving innovation for market application	*"they believe that the solution for them [manufacturers], would be recycling on chemical recycling processes. So the switch, the pivot, was very strategic for us"* (Recyc'ELIT)
Infl. on Dir. of Search	Entering CE due to social pressure/reputation	*"They [brands] have no legal obligation to recycle end-of-life shoes but are motivated by reputation risk"* (Interpreneurs, 2022)
Knowledge Dev. & Diff.	Acting as knowledge broker	*"It's very nice to do a wonderful study of the market, everybody calls me now to have information on that"* ([RE] PAIRE)
Market Form.	Engaging with region	*"We do a lot with local authorities, close to the ground"* (THE 8 IMPACT)
Legitimation	Building demonstrator /prototype	*"we are offering a replicable pilot"* (itmatters)
Resource Mobilisation	Obtaining/applying for public funding	*"we've been supported by regional funds or agencies"* (Iroony®), *"I got a little bit of grants from the Hauts-de-France region"* (iNDUO®)
Positive Externalities	Demanding transparency in brand collabs	*"We impose on the industrial partners we work with to provide us with all the necessary data for an LCA"* (Team2, 2023)

An overview of all identified processes can be found in Table B.5 in Appendix B. Now that we know the drivers and barriers and have an overview of the processes and interactions CBSs engage in, we can see where the intersection between the TIS functional analysis and the identification of drivers and barriers proves valuable. Analysing drivers and barriers in the context of the processes and interactions in which they occur is beneficial in two ways: it provides context for the specific driver or barrier and results in a more realistic view of the TIS functions. By analysing these elements together, we can develop a comprehensive understanding of how CBSs operate within the TIS, allowing us to address challenges more effectively and leverage opportunities for innovation.

Naturally, not all CBSs partake in the same interactions and processes. In my first round of analysis, I tried to identify patterns in the processes and interactions based on circular strategy (closing, slowing, narrowing) of the CBS - however, no evidence existed for assigning certain processes to specific CE strategies. In essence, CBSs across all CE strategies have the potential to engage in various activities such as collaborations with universities, database development, designing innovative textiles, or working with waste streams from the fashion industry. However, some **form of distinction** between CBSs is desirable. It makes policymakers aware of the idiosyncrasies between CBS types, which might lead to more support for CBS types that are currently falling between the cracks of governmental/regional support. Furthermore, it can aid new CBSs in anticipating challenges and opportunities they might encounter when introducing

[1]Active or process codes are codes that begin with an active verb to describe an action or behaviour

their CI to the market. After multiple rounds of analysis, I found that certain CBS characteristics resulted in distinct processes and interactions within the TIS functions. The typologies are shown in Table 5.4.

Table 5.4: Four global CBS typologies used to differentiate between CBSs within the functional analysis.

Typology	CBSs
Industrial	THE 8 IMPACT, Recyc'ELIT, Refact (iNDUO®), EverDye, Iroony®
Non-industrial	itmatters, Prolong, [RE] PAIRE, iNDUO®
Digital component	itmatters, Weturn, THE 8 IMPACT, Prolong, [RE] PAIRE
Produce textiles	Weturn, Iroony®, iNDUO®

The distinction between industrial and non-industrial was made based on the following: the CBS is (planning on) building an industrial plant themselves, with a CI that is directly related to the technological processes within this plant [2]. Using the typologies from Table 5.4, I conducted a functional TIS approach, detailed from Subsections 5.3.1 to 5.3.7. Each Subsection focuses on a TIS function, aiming to identify and describe the activities that CBSs engage in within that function. When distinctions in processes and interactions based on the typologies in Table 5.4 occur, they are explicitly mentioned.

5.3.1. TIS F1: Entrepreneurial Experimentation

Entrepreneurial experimentation describes the process itself, and social learning process, of probing for new technologies and applications (Bergek, Jacobsson, et al., 2008). Within my case studies, **three themes** emerged: market research and fit, mgmt. and recruitment, and business model and pricing.

Market Research and Fit

All CBSs within my case study conducted **market research** when developing their CIs to ensure a proper market fit. The importance of market research is emphasised by itmatters, who argue that *"if you don't know the market,...how the industrial setup is organised within each ecosystem environment, then you are not in capacity to propose a turnkey solution"*. Activities within market research included *"benchmarking the market [for recycling solutions]"* (Batirama, 2022) and *"understand[ing] [brands'] needs"* (Ça Bouge, 2022), and involved interactions with manufacturers, suppliers and industry stakeholders. Incubators and accelerators were flagged as important actors within market research, due to their connections and established playbooks for market research. For CBSs that produce textiles, interactions involved brands and end consumers to gauge market perception. Iroony® highlighted that they *"want[ed] to adapt [the material] to be as close as possible to the expectation of potential users of the material"* Weturn had to realise through market research that *"recycling was rather poorly perceived, not very desirable"* (Ça Bouge, 2022).

For industrial CBSs, the focus was on meeting **industry-specific s pecifications.** EverDye highlighted the necessity of meeting industry criteria, noting, *"you have the criteria of the market...we need to be sure that the product is replying to these criteria"*. Furthermore, EverDye emphasised the importance of *"[integrating] into existing dyeing infrastructure...this removes a significant barrier to adoption."* Brand collaborations are pivotal for all CBSs, offering access to specifications and expertise, while direct interactions with manufacturers/suppliers help industrial CBSs align their technologies with current supply chains and processes. Brand interactions can facilitate the interaction between CBS and parties further up the supply chain, but it is not necessary. Weturn recalls: *"first we [went to] see the people on the ground, and then the textile producers...and then work[ed] our way up the ladder...if we want to do circularity right, we have to succeed in coordinating all the trades and all the players"* (La Seconde Vintage, 2024a).

Management and Recruitment

Start-up management and recruiting skilled employees were found to be significant challenges for CBSs. Especially for industrial CBSs, constructing **internal processes** [3] is challenging. EverDye explained that *"as you go from R&D start-up to an industrial start-up, you need to change all your internal processes"*,

[2] Note that it is still possible for CBSs to aim for industrial scale (as for [RE] PAIRE, for example, but not being classified as an industrial CBS due to their CI not taking place in the plant. However, [RE] PAIRE's goal is to by industrial).

[3] Processes included setting up *"training to help [employees] gain skills in maintenance"* (THE 8 IMPACT), or to *"check the safety"* of the process (Recyc'ELIT).

while Weturn expressed how *"processes at first, are non-existent"* (Visconti Partners, 2023). **Recruiting talent** is another hurdle; iNDUO® leveraged a partnership with a university to recruit, stating, *"thanks to our partnership with GEMTEX...we have a large pool of talents to recruit [from]"*. Regarding **management**, mentioned challenges were to *"ensure that everyone is aligned with the company's ambition and objectives"* (Visconti Partners, 2023) and balancing entrepreneurial activities, such as R&D, business development and resource mobilisation. Recyc'ELIT mentioned that *"I did a lot of business development by myself, because when you run a start-up, you do everything"* and Prolong explained that *"with the limited capacity...we have to be super cautious...with the priorities we are working on"*.

Business Model and Pricing

A crucial process is finding a **profitable business model**. Its complexity was noted by 8 out of 9 CBSs and did not discriminate between CBS types. In a podcast, Weturn argues that *"there is a massive complexity on the business model of circularity"* (Visconti Partners, 2023). No conclusive findings on the specific process of finding a business model were identified in this research, but scaling up was mentioned by numerous CBSs as a tool to improve the cost proposition of their CI. This is necessary, as *"currently everybody wants something environmentally friendly, but at the same price"* (iNDUO®). Non-circular counterparts are often less expensive, making them more attractive to price-sensitive consumers and brands. Although this seems like a barrier within the market formation TIS function, it does influence the entrepreneurial experimentation of CBSs in fashion. In our interview, Weturn explained that *"recycled fabric prices are above the version of scale prices. So, [we're engaging in] great R&D on this pricing topic"*.

In summary, important processes for CBSs are to engage in extensive market research, develop internal processes, recruit skilled teams, and develop BMs. These efforts require continuous interaction with industry stakeholders, driven by incubators, brand collaborations and ecosystem associations.

5.3.2. TIS F2: Influence of Direction of Search

Influence of direction of search describes all activities, interactions or events that encourage actors to enter into a TIS. Within my cases, CBSs had various reasons for entering into their respective TIS. [RE]PAIRE realised how shoes are one of the few products for which brands have no repair solution, while others innovated as the technology for their preferred application was non-existent: Recyc'ELIT explains that *"the need was to address these complex textiles based on polyesters, because nobody else was able to process [them]"*. From the CBSs' perspectives, various influences on the direction of search exist for industry stakeholders:

- Each CBS has mentioned the **changing regulatory landscape** to be a key influence in forcing brands, retailers and manufacturers to enter the CE. EverDye reflects how *"all of these regulations that are happening, are strengthening what brands need to do. Better end of life management, fewer emissions, all these impact how brands need to change how they work"*. Some explicitly noted on the change they observe within the industry. Iroony® recalls that *"especially compared to when we started, brands are really looking for alternative solutions considering the new regulations"*.
- Recognising the **urgency of the climate crisis** forms another incentive for actors to enter the CE. Interestingly, only the industrial CBSs mentioned this factor. EverDye mentioned in a news article that *"the market already knows we can't go on like this"* (ANDAM, 2022), while THE 8 IMPACT posted that *"retailers and brands are gradually integrating environmental costs into their operational and financial decisions"* (THE 8 IMPACT, 2023a).
- **Social pressure** was mentioned by two recycling CBSs to form an importance influence on the direction of search for brands and retailers. Recyc'ELIT explains how *"there is social pressure...so I believe that also contributes to make brands push to take up actions"*.

However, there are contradictions between the points above, especially regarding social pressure and regulations: the fashion industry expert interview revealed how *"the communication of the rules is complicated...the EU, or ADEME, try to make it understandable, but in the end, when people dress themselves in the morning, it's complex: for cotton, there is a perception that cotton is amazing, is ecological...[brands are] making terrible communication about that"*. The latter suggests that despite efforts from regulatory bodies to clarify sustainable practices, brands' marketing often leads to misconceptions about materials like cotton. Consequently, while regulations aim to guide eco-friendly choices, social pressure influenced

by flawed communication from brands can result in decisions misaligned with sustainability goals. In conclusion, there was an overwhelming consensus on the role of regulations in guiding sustainability, with some CBSs also mentioning a sense of urgency and social pressure exerted by governments, consumers, and ecosystem associations. However, the effectiveness of social pressure remains unclear if the right solutions are not sufficiently communicated.

5.3.3. TIS F3: Knowledge Development & Diffusion

Knowledge Development & Diffusion describes the creation and evolution of a TIS's knowledge base and evolution (Bergek, Jacobsson, et al., 2008). Other than the internal R&D that each CBS engages in, multiple **processes and interactions emerged:** CBSs can take on the role as educator or knowledge broker, CBSs engage in collaborative research, learn from brand or industrial- partnerships, and generate their own data. The four processes and interactions will be elaborated upon in the following subsections.

CBSs as Knowledge Brokers and Educators

Within my case study, multiple CBSs explained how their unique knowledge on the market or their circular strategy put them in a position of knowledge broker. There is a lack of knowledge for brands and retailers on how to enter the CE: *"they [brands] want to enter in this system [the CE], but they have no information on how to enter it"* ([RE] PAIRE). This was triangulated during the fashion industry expert interview, where I learned that *"[brands] have, in the beginning, no idea how to enter in the circular system"*. As knowledge brokers, CBSs are consulted for their knowledge of the market, the regulatory landscape, their technological expertise or their practical knowledge on how to facilitate closed-loop systems. These knowledge broker positions take form by participating in panel discussions, industry working groups, or consulting other actors (*"when you're talking to brands, it's as if I was doing some consulting"*, THE 8 IMPACT). The fashion industry expert even highlighted how *"there are a lot of brands that have nobody that has knowledge, there are start-ups inside the brands"*. The Care & Repair CBSs within my case study acknowledged how their interactions with brands involves **education** on the cost and logistic implications of implementing circular solutions: Prolong highlights that *"we need to educate the clients a bit"*, and [RE] PAIRE adds that brands do not yet sufficiently understand the costs and process of shoe repair. To summarise, the interactions within knowledge brokerage are mainly with brands and within ecosystem organisations.

Data Generation

CBSs within my case study that have digital tools play an interesting role in the development and diffusion of knowledge. They all collect data with their digital tools: for itmatters and Weturn's VALO, it is regarding garment/material flow; for Prolong and [RE] PAIRE, it is on repairs; and for THE 8 IMPACT and Weturn's sorting algorithm, it is on the material composition of incoming batches. The data generated from these digital tools is highly useful in filling the digital gap in the fashion industry (*"There is not enough data. This industry is very hard to track"*, EverDye), and provides the following insights:

- Weturn and itmatters have developed digital solutions to provide insights and information on material or product flow. This helps brands reach regulatory objectives and optimise waste streams. Weturn emphasises, *"it was super important for us to tackle the traceable traceability subjects, so to know exactly where all the stocks were going. So you triggered the reporting."*.
- Prolong and [RE] PAIRE work with digital tools that register and track repair orders. This provides useful information on customer engagement and repair logistics. Prolong explains, *"we can't promise that someone [a repair shop] will do a good job. However, we'll always promise to deliver the data and the transparent feedback to the brand."*
- Both Weturn and THE 8 IMPACT have developed databases/algorithms concerning material content. THE 8 IMPACT explains, *"for this batch...I have recognised materials that are in there, I know what's the best way [to recycle it]... and we repeat it until we have built enough data to be able to build an artificial intelligence to project what's the best way to process it"*. Weturn also engaged in this sort of data generation: *"it's [the database] 33 variables, 3 criteria of texture, colour, and composition, and it's based on the data available in the inventory. It's a sort of micro algorithm...In the end, we automated everything"* (Visconti Partners, 2023). In turn, this data can facilitate **eco-conception** within brands. For example, THE 8 IMPACT developed an algorithm scoring brands' shoes on their recyclability to encourage design simplification.

University and Research Centre Interactions

All industrial CBSs mentioned interactions with universities or research centres, benefiting from *"extremely expensive machines"* (iNDUO®, 2024), *"many years of experience"* (Iroony®), and *"the scientific community"* (THE 8 IMPACT). These interactions take several forms:

- Partnerships allowing CBSs to use facilities at research centres or universities, as with iNDUO® and THE 8 IMPACT. THE 8 IMPACT explains, *"we are hosted by them, we have access to machines."*
- Research centres or universities acting as technology providers, such as DITF for Iroony®. They explain, *"the technology provider was great and really an accelerator for us."*
- Validating or testing technologies developed by CBSs, as with itmatters' RFID technology. Itmatters elaborates, *"there is a huge structural organisation which needs to be validated by a key expert, and most of them are in those universities, definitely."*
- Outsourcing research to speed up R&D within the CBS, as was the case for EverDye. They explained, *"we always choose to have research partners...to gain time. It's all about time, because in a start-up you have a runway, you have an amount of money, and we want to spend it on the main targets."*

Many of these interactions stem from **personal connections**. THE 8 IMPACT explains, *"the professor who's heading this department [university lab in the North of France]...is one of the founders actually of THE 8 IMPACT."* Iroony® connected with DITF during a study trip and later at a conference, and itmatters connected with universities through their own network or via consortia.

Collaborative Research and Learning

CBSs engage in collaborative research projects, including pilot projects with brands, consortium research projects, and partnerships with industrial partners. **Pilot projects with brands** allow CBSs to benefit from their know-how and network, and helping the CBS create a roadmap: Recyc'ELIT noted that brands push CBSs to *"be industry ready"*. CBSs can forge connections with **industrial partners** via brand collaborations, regions, or their own initiative, which is specifically useful for industrial CBSs: access to industrial facilities is vital for development and scaling up of the technology. EverDye explains how industrial facilities *"allow you to iterate quickly, accelerate your development"* and *"help you understand how your technology reacts in different machinery,...you get a deeper understanding of basically your own technology."*. Collaborative research projects are also a significant source of knowledge development and diffusion, especially for industrial CBSs engaged in international collaborative research programmes (e.g. European Horizon projects) or ecosystem association programmes (e.g. Refashion's Innovation Challenge). Although the application process to these collaborative projects can be lengthy, Iroony® shared that the application in itself is *"a way to structure the project... also good on the issue of networking."*

An important activity relevant to all the above is the strategy surrounding **intellectual property (IP)** within CBSs. Seven out of nine CBSs in the case study have patented solutions. French start-ups benefit from personalised (low-cost or free) support from the INPI, a national institute for IP. Iroony® recalls, *"we did training with them [regional INPI Agency], a master class on IP, with personalised training sessions"*. EverDye stresses the importance of IP attorneys, stating, *"especially if we outsource our production...we need to be sure that we are protected. So yeah, it's very important to have a specialist in IP"*. Patents are not only important for IP protection, but I found they facilitate two other types of interactions: first, patents serve as a clear communicative tool within interactions with technology providers or manufacturers. Second, when seeking private investments, *"you need to show you can protect your IP "* (EverDye).

In summary, there are many inter-stakeholder interactions within this TIS function. The learning process between CBSs and brands is a two-way street: CBSs need the connection to the industry to further industry-specific innovation, and brands learn from CBSs on circularity-related topics. Collaborations with universities and research centres are important hubs of innovation, and interactions with CBSs are leveraged by personal connections or collaborative R&D programmes.

5.3.4. TIS F4: Market Formation

Market formation refers to the development of a market around a product or technology (Jansma et al., 2018). The CBSs within this research differ hugely, and so do their respective markets. However, there are three high-level processes relevant to all, which I will discuss in the subsequent Subsections.

Creating Awareness for Innovation

Before anyone can adopt a technology, they must know about it. All CBSs within this research are actively engaged in numerous interactions and activities to create awareness:

- Attending **fairs and conferences** drives CBSs' visibility and provides a great place for the identification of opportunities. Recyc'ELIT explains how *"fairs and conferences help a lot because it gains you in terms of visibility"*, an experienced shared by Iroony® and Weturn.
- For young CBSs, **ecosystem associations** have proven an efficient way to gain visibility and raise awareness on their CI. THE 8 IMPACT state in a LinkedIn post how *"thanks to these to eco-organisations for giving us the opportunity to raise awareness about the profession of valoriser"*.
- As mentioned before, a relationship with the **region** of the CBS can result in heightened visibility.
- **Incubators and accelerators** have shown to be a good source of networking and creating awareness for CIs. For example, iNDUO® joined the Amazon Sustainability Accelerator in 2023, where they were able to meet with Amazon executives (Amazon, 2023), and Weturn met their current partner 'NonaSource' at La Caserne, Europe's largest sustainable fashion incubator.

Convincing Brands to Adopt Innovation

Consumers, brands, retailers or manufacturers must commit for the successful adoption of a CI. This has shown to be a challenging for the sampled CBS: The barriers concerning this step are inherently linked to the **slow response of the fashion industry** - difficulties securing a meeting with decision-makers, complicated decision-making units and long decision-making processes form hurdles for CBSs, as explained in Section 4.3. Recyc'ELIT summarises the latter by stating that *"[the challenge] is, first, to bring them around the table to have their interest, and then to convince them to...stick to your proposal and then make them pay"*. However, what drives this process within this TIS function, is that if one brand commits, others will follow, as explained in Subsection 5.3.2. Other things CBSs can do to incentivise brands to adopt their solution is *"...to test for free, to gain their confidence"* (Recyc'ELIT). Interactions that have been mentioned within the processes of market formation that lead up to the commitment of brands are approaching them with a value proposition, scheduling meetings through a personal network, or via ecosystem associations.

Implementing Innovation

The process surrounding implementing a CI depends heavily on the type of customer, CBS and CI. Despite the differences, general takeaways emerged throughout my case studies regarding the difficulties and opportunities in CI implementation:

- The implementation of the CI in itself can be a challenge. Weturn revealed that *"one of our challenges is to successfully implement our logistics solution with our customers"* (Maddyness, 2022). Specifically for CBSs with a (B2B) digital tool, adapting to the heterogeneity of IT ecosystems is challenging. Furthermore, [RE] PAIRE emphasises how successful implementation requires both top-down and bottom-up support: *to succeed, all staff must be made responsible, starting with the executive committee and including in-store sales staff. Don't make start-ups bear all the costs"*.
- Brand or supplier expectations regarding **production minima** can inhibit the industrial CBS's ability to meet customer expectations. Recyc'ELIT revealed that *"there are other brands which would say, I don't talk to you under half a ton"*, and iNDUO® recalls: *"we had this first fabric tested, it's good enough. So then I order, at the supplier I could only order, I think it was 1500 metres. It was the minimum"*. Especially when client orders are limited, this forms a barrier for CBSs to implement their CI at scale. THE 8 IMPACT adds that demand can be unpredictable: *"suddenly all the brands will place their orders at the same time, because they will all need a marketing story at the same time"*.
- Lastly, the lack of **transparency** forms a barrier during CI implementation. one expert interview revealed how *"in textile, there is a secret culture. Like a cook, you don't give your recipe. If you find a good producer of yarn, of cotton, you don't want to put it out there"*. This point yielded contradicting results, with some CBSs recognising the problem, while others did not, but attributing the lack of transparency due to a lack of information on the brands' side.

In short, the high-level processes within Market Formation are creating awareness for the CI in question, getting brands to commit, and implementing it. The main barriers within this function are inherent to the fashion industry's slow response to circularity, and the lack of standards in both logistic workflows and IT ecosystems, and the lack of negotiation position for industrial CBSs.

5.3.5. TIS F5: Resource Mobilisation

Within the TIS function of Resource Mobilisation, three main processes were identified: obtaining public funding, private investments, or operational resources. All three are elaborated on in this Section.

Public Funding

For the CBSs in this research, public funding was an important source of financial resources. Public funding includes regional funds, national funds (e.g., France 2030 investment plan), EU Cascade projects, and bank loans backed by public funds (BPI France, 2024; European Commission, 2024; The French Agency for Ecological Transition, 2022). Ecosystem associations, such as Refashion, also financially support R&D projects of innovations in fashion, exemplified by their 'Innovation Challenge' which iNDUO®, Recyc'ELIT, and THE 8 IMPACT have participated in (Refashion, 2021). Especially for industrial CBSs, public funding is a *"device for industrial projects"* (Iroony®). However, the public financing landscape is complex to navigate for CBSs. Even though regional entities often position themselves as contact points for CBSs, one CBS expressed in an interview that *"it's actually quite time-consuming to navigate between different [regional, national] entities...they have different ways of working, and different expectations"*.

An interesting **interaction between public and private funding** was highlighted by THE 8 IMPACT, who stated: *"regional funds to instil confidence in private funds? Increasingly becoming a reality"* (THE 8 IMPACT, 2023b), but Iroony® expressed that national funding is often *"capped by equity"*, implying that to obtain a higher amount of public funding, equity must be raised. [RE] PAIRE confirmed this for subsidised bank loans, as they recalled how BPi, a French bank, told them: *"before we reinvest in your firm, you need to have a private investor"*. Unfortunately, obtaining private investments is not an easy feat for some CBSs, which I will explain in the following subsection.

Private Investments

Private investments include VC investment, crowdfunding or funds from angel investors. For the sampled CBSs, we see that every CBS that has been **incubated or accelerated**, has been successful in their investment stages - EverDye, Prolong and Recyc'ELIT have raised 3.4, 1.5 and 3.2 million in seed round funding, respectively (Callum Cyrus, 2023; Fashion Network, 2024; l'ESSOR, 2023). Incubators can either be the lead investor, or strongly drive private funding by fostering connections with investors and backing up the CBS legitimacy-wise. For CBSs that are not connected to any incubator or accelerator programme, obtaining private investment is experienced as difficult. Itmatters explains that *"the return on your investment would be different"* for circular businesses, and that that is difficult to convey to investors. During my interview with the CIF, I learned that *"a big challenge for start-ups is to demonstrate that they...will benefit from the first mover advantages...VCs like to surf existing markets rather than hypothetical future markets, that's why circular companies must be so good to succeed. They need to catch the right opportunities, regulations are often a good one, find partners, and understand their waste stream perfectly"*.

Operational Resources

Within operational resources, I include all resources excluding financial resources necessary to operationally support the development or implementation of the CI. The following operational resources were deemed as necessary by CBSs in this research:

- Securing **sufficient feedstock/textile waste streams**. A weaker negotiation position, limited resources and the seasonality of the fashion industry can result in a **lack of access to feedstock**, respectively. Ecosystem organisations, such as Refashion, play an essential role in providing CBSs with waste streams by funding over-sorting and educating sorting centres, ensuring CBSs *"don't pay the feedstock"* (THE 8 IMPACT). The CIF's perspective provides insight on why it is vital for CBSs to have a clear view on these waste streams: *"What is the size of the waste stream? Are we paid to get those streams or do we have to pay?...having clear ideas of the volumes is crucial"*.
- The implementation of circular solutions can be slowed down due to a **lack of suppliers or manufacturers** in France. For example, Iroony® expresses how the hemp stalk materials *"require specific spinning mills which do no longer exist in France"* (ADI Nouvelle-Aquitaine, 2022). Again, for industrial CBSs, interactions with the region can put the CBS in contact with technology providers or actors in our outside of France, thereby fostering the connectivity of start-ups.

- Finding a **suitable plant and/or equipment** is crucial to the scaling up of a CI's technology. For industrial CBSs, the region has proven to play an important role in finding a suitable location for CBSs. For Recyc'ELIT, the region helped them secure a location to house their demonstrator.

In short, obtaining sufficient resources is challenging for CBSs. The interactions regarding financing are mainly with regional entities, banks, and investors. Interaction with incubators and accelerators greatly drives start-up financing, and ecosystem associations and the region can assist CBSs in securing waste streams and a suitable location. Of course, brands can also invest in CBSs, or CBSs can generate revenue themselves. However, this was not mentioned as frequently in the interviews - concluding that, especially in the beginning, CBSs are mostly reliant on public or private financing to fund development and growth.

5.3.6. TIS F6: Legitimation

Within legitimation, we clearly see a distinction in the case data between industrial and non-industrial CBSs, and whether their innovation concerns a process or a product. The industrial CBSs that provide a process all undertake actions towards building a **demonstrator or prototypes** to prove that their technology works and/or is scalable. Iroony® simply states that *"prototypes are very, very key"*, and EverDye argues that *"you need to send samples that show that you can meet the criteria of the market. And then this will encourage them to go into the industrial phase"*. Closely related to the latter, is that CBSs should be able to **show the CI actually helps decarbonise, save energy, or reduce waste.** This is slightly different from a demonstrator or prototype, since a circular prototype could have been produced with the same environmental footprint as a regular, non-circular item. iNDUO® states that *"we have to do LCAs and show the impact is positive"*. With this, **LCAs, PEFs** or other impact measurement methods are necessary. Not only is this important to get brands on board, but also investors. The CIF emphasises that *"for us circular first funds, we need to validate the circular aspect. The impact on waste streams need to be substantial, and the circular impact should not be diluted"*.

A final driver for legitimacy within CBSs is industry-wide recognition, which can in the form of **awards, eco-labels, certificates or acknowledgements.** Although they increase a CBS's legitimacy, participating in competitions or obtaining certificates/labels is resource consuming. Weturn acknowledges that although the process of obtaining their BCorp status was worth it, it *"was quite long...it was painful"*. When asked about the strength of legitimacy obtained from awards and labels, THE 8 IMPACT reflected that *"it definitely helps, but it's not enough to give you legitimacy, because there are so many examples of start-ups who got all these labels or awards and still they don't manage to succeed because they didn't find their business model"*. To summarise, processes that drive legitimation are the creation of demonstrators, proof of impact and obtaining eco-labels, certifications and, in some cases, awards.

5.3.7. TIS F7: Positive Externalities

Positive externalities were not mentioned directly by CBSs, but some can be identified when assessing the effects of certain TIS functions on one and other. First, the increasing number of CBSs in fashion result in the **growth of ecosystem associations** such as the Féderation de la Mode Circulaire, FashionForGood and Paris Good Fashion. For example, the Féderation is only 3 years old, but already has accumulated over more than 250 members. During the expert interview with the PNEW Agency, I learned how *"the laws are not the same, we are not speaking about the same things...translations are not the same. The Féderation does a lot of work on being experts on this topic and diffusing this knowledge"*. By increasing literacy on complex topics in the industry, together with creating a shared language on these topics, ecosystem associations can more easily mobilise stakeholders and construct reports to inform and steer policy makers. The more these associations are **heard by officials,** the better the regulatory and policy environment will be adapted to support CBSs in their innovation and market introduction.

On top of that, the increasing amount of CIs within fashion results in an increasing amount of knowledge on circular solutions, which validates business models and increases circular literacy. Prolong explains how the latter helps *"accelerate the market education around [CBMs]...with the power of...a group of companies, who could be also competitors,...trying to achieve the same goal"*, triangulated by Weturn: *"I think you're lucky to work in an industry where there's a lot of innovation, where there's a lot of new models being launched... So nothing's perfect, but there are things to learn about these kind of circularity [approaches]* (Première Vision, 2023). Iroony® remarks how there increasingly is *"a better know-how from*

brands on the topic of material. So it makes things easier to interact". Lastly, the collaboration between brands and CBSs gives rise to the positive externality that these brands become **increasingly transparent.** THE 8 IMPACT write how they *"impose on the industrial partners we work with to provide us with all the necessary data for an LCA"* (THE 8 IMPACT, 2023a). This goes to show that not only the CBSs who, because of the nature of their innovation, improve transparency and traceability in the industry, but also CBSs that are not inherently linked to transparency and traceability drive brands to transparency.

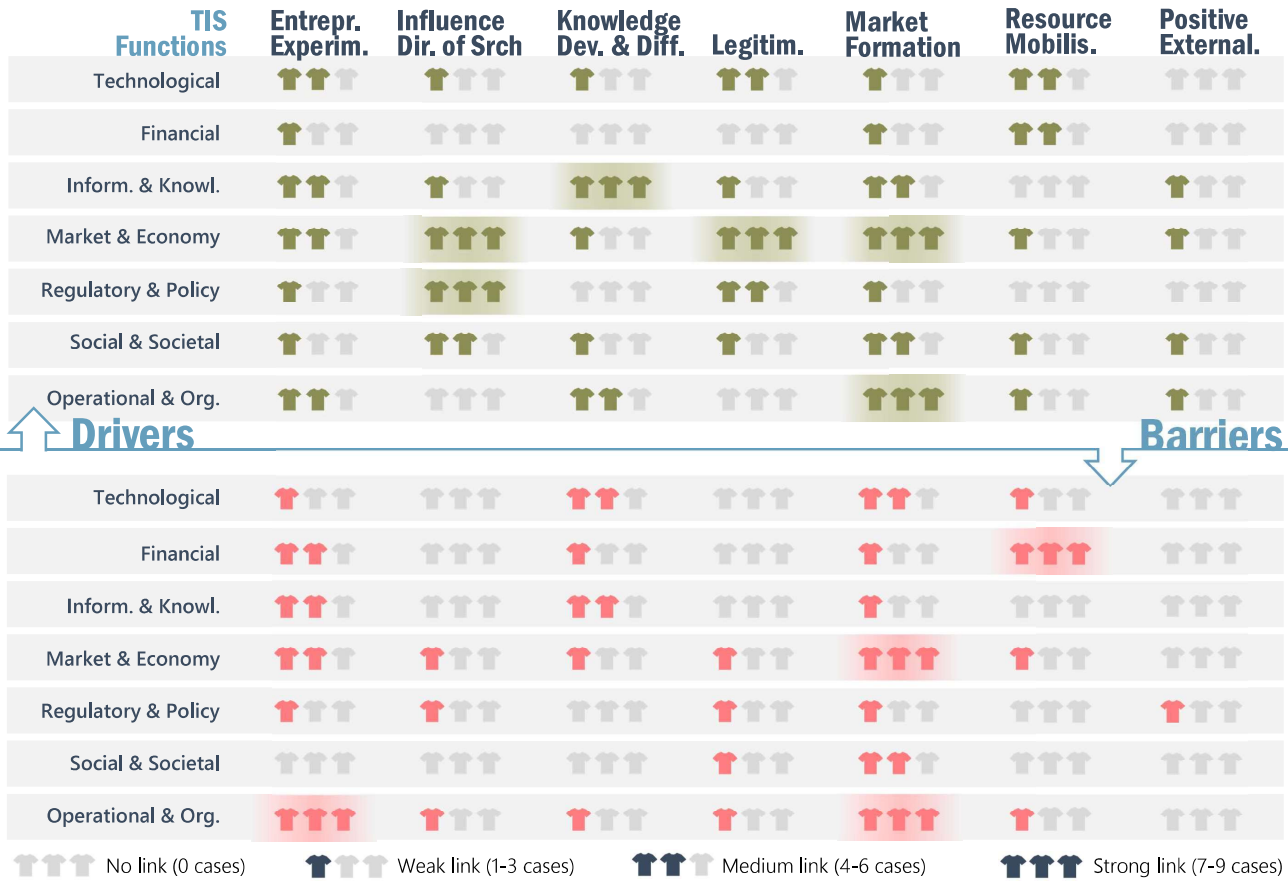
5.4. Inducement and Blocking Mechanisms

Sections 5.1 and 5.3 provided the results needed to answer SQ 1 and 2, respectively. With this rich understanding on what drivers and barriers, along with what processes and interactions CBSs experience in when introducing their CI, we can identify what the main influences are that hinder or block their market introduction, therefore answering SQ3. As explained in Chapter 2, inducement and blocking mechanisms are *"mechanisms that either induce (drive) or block a development towards the desirable functional pattern"* (Bergek, Jacobsson, et al., 2008, p. 414). This Section provides the analytical approach followed to identify these inducement and blocking mechanisms, along with the results.

5.4.1. Drivers, Barriers and TIS Functions: Identifying Strong Links

As explained in the methodology, text fragments were coded according to process/interaction and driver/barrier, along with their overarching categories and TIS function (see Figure 3.2). This coding was applied to qualitative data spanning 40 documents across all cases. Figure 5.3 illustrates the results, showing the **co-occurrences of driver and barrier categories with the relevant TIS functions.** This approach allows us to assess the strength of the link between each driver/barrier category and the corresponding TIS function. For example, if multiple cases highlight difficulties in managing start-ups during the entrepreneurial experimentation phase, the frequency of this co-occurrence indicates the significance of this barrier within that specific TIS function.

Figure 5.3: The links between the empirically identified drivers and barriers, and the respective TIS functions they were relevant to



In Figure 5.3, the strength of the link is depicted by the amount of T-shirts at the respective co-occurrence. Co-occurrences depicted with three T-shirts imply that the link found is strong, meaning that 7 or more CBSs encounter a specific driver or barrier within a certain driver/barrier category within a specific TIS function. These co-occurrences provide a good overview of which factors affect the different TIS functions for CBSs in general, the latter implying no differentiation is needed between the different CBSs: almost all CBSs experience barriers of operational and organisational nature during Market Formation, and almost all CBSs benefit from regulatory drivers in the Influence of Direction of Search within their TIS. Although this is insightful, more specific analysis is needed to be able to pinpoint the inducement and blocking mechanisms.

5.4.2. Filling in the Links

Using Figure 5.3 as a foundation, Figure 5.4 was created to visualise the main drivers and barriers within the seven driver/barrier categories and show which TIS functions they affect. By highlighting the most frequently mentioned drivers and barriers in each category, Figure 5.4 provides more detailed insights than Figure 5.3. Strong links identified in Figure 5.3 are marked with thick arrows. Additionally, Figure 5.4 reveals specific drivers or barriers that primarily impact certain CBS typologies, such as industrial versus non-industrial CBSs. At a high level, Figure 5.4 illustrates that drivers impact almost all TIS functions, whereas barriers from all categories tend to cluster around and hinder Market Formation for CBSs. Operational & Organisational and Market & Economy barriers are particularly common across most CBSs. There is also an imbalance between financial drivers and barriers: many CBSs face financial barriers to Resource Mobilisation, while financial drivers are more common for specific CBS typologies, such as industrial CBSs or those associated with an incubator/accelerator.

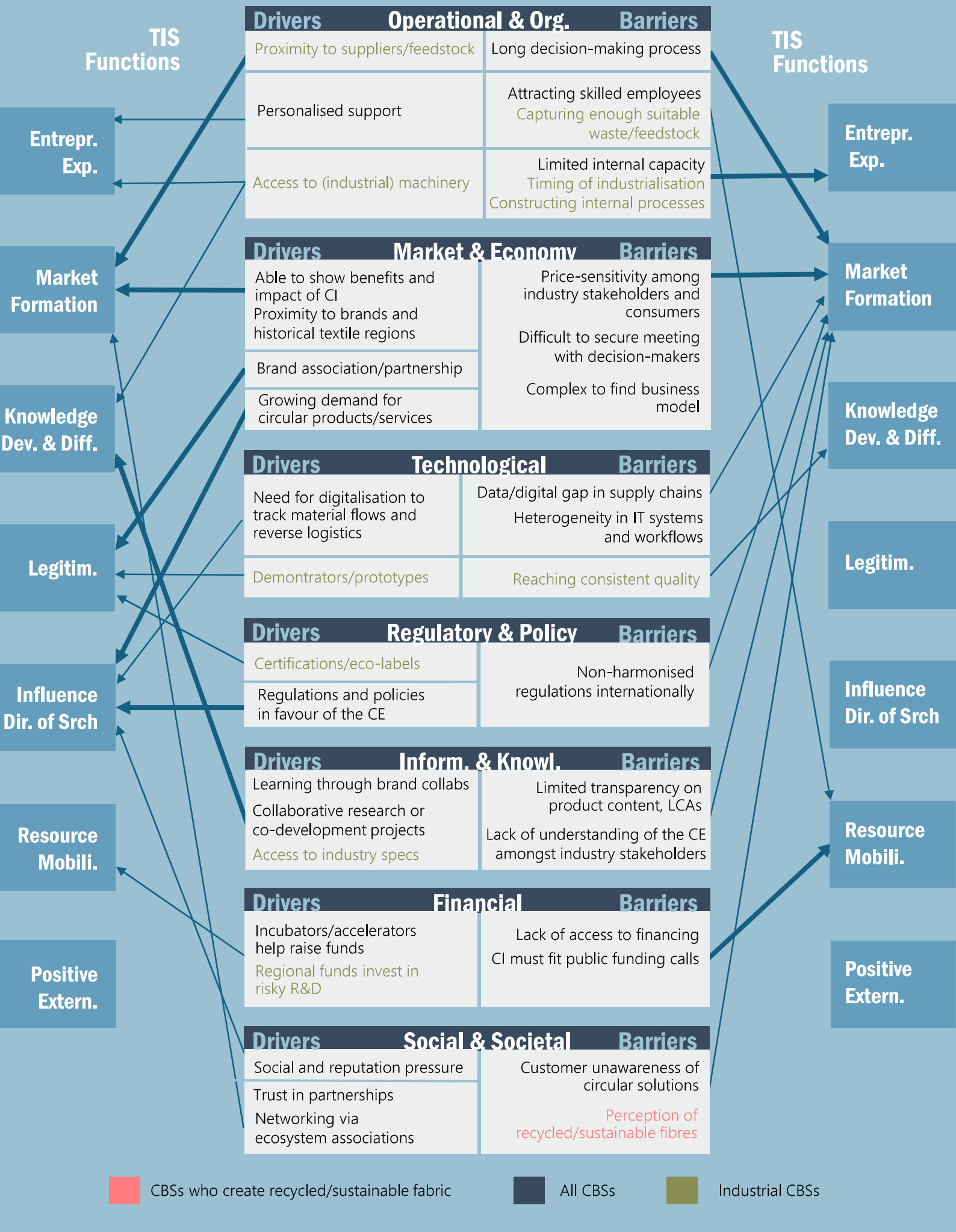
Although Figure 5.4 provides valuable insights into the most frequently mentioned links between drivers and barriers and the TIS functions they affect, it does not yet identify the inducement and blocking mechanisms. The drivers and barriers include both internal and external factors, and although inducement and blocking mechanisms can be both endogenous and exogenous, they must be factors 'pushing and pulling' the TIS as a whole, rather than internal drivers and barriers affecting TIS functioning. For example, the ability to demonstrate the benefits and impact of a CI is an important driver, but it does not constitute an inducement mechanism. In the next section, I will identify these inducement and blocking mechanisms.

5.4.3. From Links to Inducement and Blocking Mechanisms

Using the insights from Figure 5.4, Figure 5.5 identifies the inducement and blocking mechanisms for CI introduction by CBSs. It shows how external factors, such as regulatory changes, increasing awareness and regional support, influence the different TIS functions. Therefore, the transition from Figure 5.4 to Figure 5.5 represents a progression from identifying the broad spectrum of drivers and barriers to pinpointing the specific mechanisms that drive or inhibit CI within the fashion and textile industry. By tracing the connections between these external influences and the internal functions of the TIS, we can better understand the underlying inducements and barriers that shape the adoption of circular solutions in the industry.

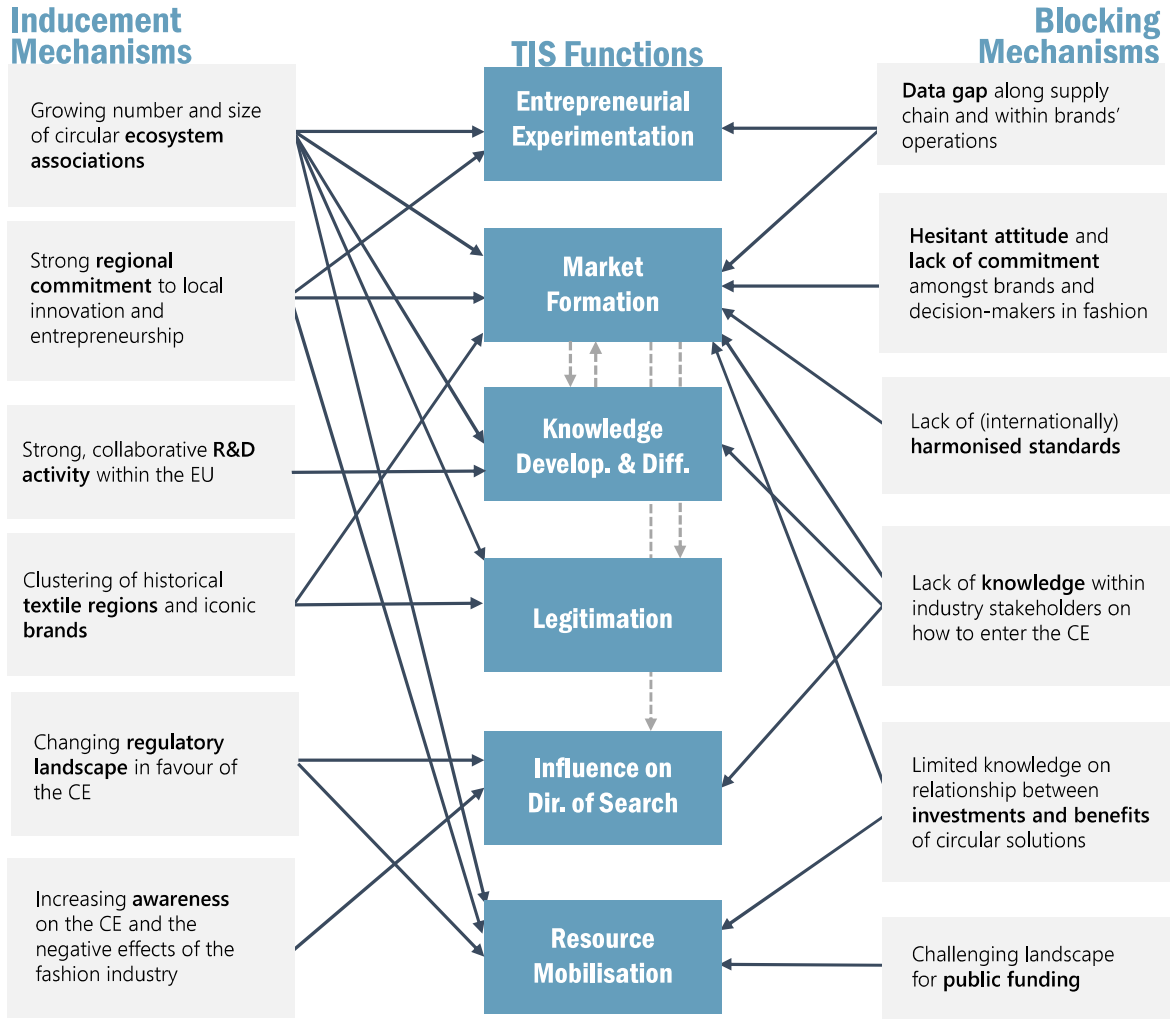
When looking at the inducement mechanisms, arguably the most essential one for TISs in fashion and textiles is the changing **regulatory landscape** in favour of the CE. The latter strongly pushes brands to seek for solutions for what they put on the market, track their material flow and goods, and extend their product responsibility. In France, these regulatory changes effect CBSs within resource mobilisation (e.g. the France 2030 Investment Plan) and Influence on Direction of Search. Furthermore, the **increasing awareness** amongst industry players and consumers is pushing actors to enter the CE. Another inducement mechanisms is presented by the clustering of both historical textile regions in France, and the existence of many iconic brands who act as trend-setters and examples within the global fashion community. Obtaining commitment, recognition or an award from these brands greatly enhances legitimacy, but proximity to these actors enhances the logistics of creating a circular ecosystem as well.Interesting inducement mechanisms are ecosystem associations and the region: they both strongly influence Entrepreneurial Experimentation, Market Formation and Resource Mobilisation of CBSs. However, when we refer back to Figure 5.4, the drivers facilitated by the region mainly address industrial CBSs (e.g. 'access to (industrial) machinery', 'proximity to suppliers/feedstock', 'demonstrators/prototypes'). Hence, the **strength of the influencing mechanism** of regional support may not be as strong for non-industrial CBSs as it is for industrial ones. For ecosystem associations, the influencing factors are more democratised:

Figure 5.4 The links identified between drivers, barriers and TIS functions. Drivers and barriers in black apply to all CBS types; text in green refers to industrial CBSs; text in pink refers to CBSs creating recycled or sustainable fabrics.



personalised support and providing connections within brands to form partnerships were not mentioned by one specific type of CBS. Lastly, the R&D activity within the EU is strong, contributing to collaborative research opportunities within TISs. These research calls (such as the Galactica and WEAVER Horizon project that Iroony®, iNDUO® and itmatters participated in) are open to a wide range of experts and provide funding, hence forming a great environment for CBSs to develop their own knowledge further and build lasting connections with their research partners.

Figure 5.5: Inducement and blocking mechanisms for CI introduction by CBSs in the textile and fashion industry in France. Strong inter-functional effects are visualised with interrupted grey arrows.



When looking at blocking mechanisms, there is a range of contextual factors hindering the proper development of the TIS functions. First, the logistic/business implications for brands when entering the CE, and the investment vs. benefit construction of circular solutions are not well understood. This inhibits CBSs from reaching long-term commitment from brands and obtaining private investment. Second, we learn that strong links exist between the barriers CBSs face regarding the slow response of the fashion industry. The blocking mechanisms with respects to the latter is the hesitant, wait-and-see attitude amongst industry players is halting the adoption of new technologies, which greatly affects Market Formation for circular solutions. Another strong link from Figure 5.4 that translates into a blocking mechanism, is the challenging landscape of public funding. Figure 5.4 shows how the general lack of access to financing, combined with the fact that funding calls often have a description which is not applicable for all CIs, makes it difficult for CBSs to obtain public funding. This blocking mechanisms can be experienced as less or more challenging depending on the CBS type - again, industrial CBSs were found to benefit more from public funding, since their objective fits in well with innovation objectives within regions or territories.

There are two interesting 'high-level' observations we can make from Figure 5.5. First, we see that the inducement mechanisms are primarily of macro level nature, and are not industry specific - this contrasts the blocking mechanisms, which occur more at meso level and are industry specific. Second, we see that inducement mechanisms affect a wide range of TIS functions, while the blocking mechanisms predominantly affect Market Formation. This finding suggests how the overall environment that CBSs operate in stimulates innovation, but obtaining commitment from the industry to actually adopt it blocks market introduction.

In Figure 5.5, strong **inter-functional mechanisms** are shown with the interrupted grey arrows. An important mechanism for CBS active in the fashion and textile industry is between Market Formation and Knowledge Development & Diffusion. Figure 5.5 shows how there is a strong link between market-specific knowledge development (e.g. learning through brand collaborations, access to industry specs, and co-development) and Knowledge Development & Diffusion. The stronger the Market Formation is within the CBS's TIS, the stronger the relationships become between the innovative parties and the industry. This allows for innovations to be better fit to market needs on the one hand, and knowledge development and diffusion to be better targeted to industry specifications and quality requirements on the other. Furthermore, Market Formation strongly influences Legitimation and Influence on Direction of Search. Figure 5.4 shows a strong link between brand collaborations and Legitimation, suggesting that working with a brand increases the legitimacy of a CBS. Furthermore, one brand collaboration will likely spike the interest of other brands (*"you have this follow-up effect, when they see that you're working with [a brand]...you gain interest of [brands]"*, Recyc'ELIT) - the stronger the Market Formation, the more brands will likely enter, hence influencing the Influence on Direction of Search. The latter is especially relevant for fashion: seasonality, reputation, image and 'newness' are important selling factors for brands (*"brands, they have only two collections per year. And on each collection, they are increasing the degree of what they want to do"*, [RE] PAIRE).

5.5. The Results from an Abductive Approach

As detailed in the methodology, the abductive approach adhered to within this study resulted in pivots in the research direction, inspired by new or surprising empirical findings. To account for these pivots, and provide transparency on their effects on the research, I set out to briefly describe them in this Section:

- First, early analysis results showed little meaningful differences between the perceived drivers, barriers, processes and interactions experienced by CBSs pursuing different circular strategies. This was implicitly expected before analysing the data, since the CBSs themselves fit nicely into the circular strategies and circular approaches formulated beforehand. This realisation inspired the pivot of moving the typologies from slowing, closing and narrowing CBSs to investigate differences between more 'literal' differences in **typology,** such as industrial vs. non-industrial CBSs.
- Second, SQ 1 was added during the construction of the Case Report, as the description of the benefits of all the CIs lead to the insights that all the CBSs communicated a range of benefits, and some of them overlapped. This sparked the line of investigation to see to what extent **value propositions** across CIs overlapped, and if interesting patterns could be identified.
- After reviewing the co-occurrence analysis from Figure 5.3, I realised that it would be an interesting line of analysis to further investigate whether **inducement and blocking mechanisms** could be deduced from it - this realisation stemming from going back and forth between my empirical findings, and the body of literature on the functional TIS approach.

In short, the abductive approach proved highly valuable within my research. It forced me to stay vigilant, and enabled the continuous critical questioning whether the results I was generating were in line with the research objectives, or if it would generate more value to adjust the research objectives.

06 Discussion

In this Chapter, the empirical findings from my study are discussed and compared against existing academic research. Section 6.1 provides an in-depth discussion of the findings, structured according to the three SQs. I conclude the discussion by presenting the limitations of this research (Section 6.2), and suggesting avenues for future research (Section 6.3).

6.1. Analysis and Interpretation of the Findings

In this Section, I set out to critically discuss the findings of my research. This Section is structured according to the SQs of this research: Subsection 6.1.1 discusses the findings related to the pursued circular strategies and proposed value propositions of CBSs in fashion. Subsection 6.1.2 discusses the findings concerning the identified processes and interactions, and Subsection 6.1.3 discusses the inducement and blocking mechanisms the sampled CBSs were found to endure when introducing their CIs.

6.1.1. CE Strategies and Value Propositions

The first SQ of my research asked how CBSs position their CIs within the fashion and textile industry in terms of circular strategy and value proposition. My research provides empirical insights into how CBSs engage in closing, slowing, and narrowing resource loops. This is not surprising, as these three circular strategies are high-level and, although not mutually exclusive, are collectively exhaustive. However, a surprising finding was that **not all CBSs present themselves as circular,** even when their innovations meet the description of a CI. This suggests a discrepancy between practice and communication that warrants further investigation. Even though this discrepancy exists within the sampled CBSs, I did not distinguish between 'openly circular' and 'non-openly circular' CBSs in my analysis.

However, both my theoretical and empirical findings suggest that a more nuanced categorisation — **differentiating based on circular approaches**— is suitable. This differentiation serves as a practical tool within the industry to distinguish circular solutions and align with the circular literacy levels of industry players, as emphasised by Zahra et al. (2021). Additionally, this approach connects with previous work on circularity in fashion (Franco, 2017; Ki et al., 2020; Pal & Gander, 2018; Papamichael et al., 2022). Reflecting on these findings' broader significance, using circular approaches as a categorisation method for CIs has far-reaching implications. For instance, Henry et al. (2020) employs similar categories to develop typologies for circular start-ups across sectors. This indicates that these approaches are not only relevant to fashion but can also foster commonalities between CBSs in different industries, enhancing opportunities for harmonised policymaking, cross-sectoral collaboration, and co-creation.

The circular approaches I suggest within this research are inspired by the R-strategies from Papamichael et al. (2022). To **address the idiosyncrasies of the fashion industry,** traceability and design for longevity, recyclability, durability, and compostability were added. A critical evaluation of both my work and the R-strategies is in place: both could benefit from more thorough and exhaustive definitions. Although the definition of Fashion CIs I formulated includes social sustainability, this is not reflected in the circular approaches or widely used R-strategies. **Aspects of social sustainability**, such as reducing health hazards and redesigning processes to be safer, should be explicitly incorporated into circular approaches. This aligns with Brydges (2021, p. 293), who argues that *"many CE models seem to overlook the exploitation built into industry supply chains. Brands should not prioritise circularity at the expense of vulnerable workers' welfare"*. While the CE focuses predominantly on resource loops, the transition to a CE must not compromise the health and safety of communities and employees along the supply chain. Therefore, ethical and social considerations must be integrated into existing circular strategies and approaches. Although not a inherently linked to the SQ, the above reflection could serve as input for future research into circular approaches, or inform circular strategies by actors in the fashion industry.

The second part of the first SQ addresses CBSs' value propositions. Although my research does not delve deeply into the value-capturing efforts of CBSs, my findings regarding value propositions are significant within the broader academic discourse on (circular) value propositions and value capturing. Ranta et al. (2020) link the concepts of slowing, closing, and narrowing resource loops to value propositions, proposing that these circular strategies can facilitate resurrecting, sharing, replacing and optimising value. This categorisation highlights the relevance of analysing value propositions based on circular strategies. However, my empirical findings contradict that the categorisation of resurrecting, sharing, or optimising value is consolidated within one circular strategy: for example, enabling operational efficiencies was a value propositional aspect proposed by CBSs from all three circular strategies, while this aspect arguably falls under 'optimising value' and, hece, narrowing resource loops according to Ranta et al. (2020).

Within my research, there are no concrete results on which specific value propositions CBSs with different circular strategies pursue. However, it does show how the value proposition uniquely reflects a CBS's circular strategy, circular approach, and CI characteristics. This complements Todeschini et al. (2017, p. 769), who state that start-ups create unique value propositions by *"recombining different approaches, resources, and competencies with synergetic effects."* My research adds to this by demonstrating that this recombination (1) must lead to significant benefits for potential clients, (2) encompasses both intangible and tangible benefits, and (3) extends these benefits beyond immediate clients to wider ecosystems. Points (1) and (2) connect with broader literature on innovation diffusion, while point (3) connects to the more recent work of Ranta et al. (2020, p. 299): *"CVPs in the linear economy tend to be relatively inward-looking and supplier-driven…In contrast, CVPs in the [CE] tend to be outward-looking…as they are built around novel innovations that require active participation from not only direct customers but also broader ecosystem actors."* Although based on a limited empirical base, my findings show how CBSs' value propositions can be designed to **engage a broader ecosystem.** This engagement is crucial for the successful implementation of circular strategies, as it fosters collaboration and co-creation among various stakeholders, including suppliers, partners, and consumers.

6.1.2. The Processes and Interactions of CBSs

The second SQ of my research addressed how processes and interactions shape the introduction of CIs by CBSs in the fashion industry. Although the empirical base of the findings is limited, it was possible to identify a **large range of processes and interactions** vital to successful market introduction. Before discussing the most impactful processes and interactions, it is necessary to address that each CBS within this research takes part in a unique combination of processes and interactions, based on the nature of their CI, experience and embeddedness in the fashion industry, stage of market introduction, and so on. So, answering SQ2 with high granularity would have resulted in having nine different answers for each of the nine cases, and probably 100 different answers if I had done 100 cases. Hence, this research aimed to find a way to interpret the findings concerning this SQ on a level of granularity that allows for **sufficient distinction between CBSs** were relevant, but not so detailed that generalising findings across cases was impossible. Therefore, the results should be understood within this paradigm.

Probably the most surprising result from this research was that very little meaningful findings could be identified between the kind of barriers, drivers, processes and interactions CBSs experienced or took part in based on their circular strategy. This could be explained due to my limited sample size, but also the unique characteristics of each CBS, such as differences in CBM, available resources, technology etc. Contradicting the latter, Pal and Gander (2018) were able to construct meaningful propositions based on the closing, slowing and narrowing strategies after analysing 19 cases that included larger fashion firms. Hence, the difference could be attributed to sample size, or that the larger firms within one circular strategy converge more within their processes and interactions once the size of these firms increases - of course, the latter requires more in-depth investigation, but does present an interesting avenue for further research.

To still be able to draw meaningful distinctions, I iteratively searched for a **suitable form of distinction/categorisation.** Within my empirical base, I found that the most meaningful distinctions could be made between industrial and non-industrial CBSs, CBSs with (out) a digital tool, and CBSs that (do not) produce textiles. The latter shows similarities with the work of Ostermann et al. (2021, p. 8), who analysed 10 fashion start-ups based on seven dimensions of analysis (incl. CE principle, value proposition and key activities), their conclusions are mainly based on service vs. product-based start-ups, and the distinction

between *"digital technologies and material development technology"*, which almost exactly matches the distinctions made within my research. The most evident distinction within my research was between industrial and non-industrial CBSs, which is a distinction that, to the best of my knowledge, has not been made within research on (circular) start-ups in fashion. Although this research does not provide a clear-cut explanation on why this forms a big distinction between CBSs, it could be due to a strong national/regional focus on industrial innovation within this research's empirical context, more available funds for industrial CBSs, or the imbalanced sample in which industrial CBSs are overrepresented (see Section 6.2).

Although many processes and interactions were identified, two were strongly present across CBSs, and are meaningful to discuss in this Chapter. First, I found **brand collaborations** to be particularly impactful, significantly influencing almost all TIS functions. These collaborations provide CBSs with essential insights into supply chains, workflows, quality requirements, and LCAs, ensuring a proper market fit for their CIs. Additionally, brands catalyse action throughout the supply chain, enabling the market adoption of CIs. Franco (2017, p. 839) provides an interesting perspective on this, as they found that a firm's position within the supply chain greatly influences its ability to drive change and encourage others to *"co-innovate for circularity"*. Firms at the supply chain extremes, like large manufacturers or brands, have more influence than mid-chain firms, such as spinners and weavers. I must add that these catalysing actions are predominantly relevant for brands with high levels of vertical integration, making it especially attractive for CBSs to target large, influential brands as potential clients.

However, Todeschini et al. (2017) highlight a gap between incumbent fashion brands willing to innovate and CBSs striving to scale their BMs. My findings suggest that CBSs collaborate with **visionary brands** already adopting circular practices to circumvent this gap. This corroborates with literature suggesting that proactive actors in the fashion industry are more likely to embrace sustainable solutions (Majumdar et al., 2022; Pedersen et al., 2018). My research adds insights by showing that certain CIs are particularly valuable to brands with **more complex logistics, material flows, and repair workflows**, as their logistic pain points are more prevalent. Franco (2017, p. 833) represents the incumbents view on the above: *"the notion of circular production systems is at the intersection of different research areas such as sustainable product design, sustainable supply chains, and reverse logistics…knowledge on how these concepts combine to ease or impede firms' transition towards circularity is scarce"*. My research suggests that CBSs often possess the necessary knowledge to aid firms in transitioning to CE, designing CIs that integrate circular services, logistics, and digital tools.

Secondly, **sharing knowledge and experience** with other industry actors significantly enhances the market introduction of the sampled CIs, which adds to Todeschini et al. (2017), who find that ecosystems of like-minded firms enhance knowledge and resource sharing, especially for start-ups. In my empirical context, these interactions occur through workshops, panel discussions, collaborative research, consulting and working groups. Le Feber and Smit (2023) agree with the efficacy of these types of interactions, as they argue that learning and innovation processes in the fashion industry happen through doing, using, and interacting, as knowledge is complex and tacit. Perhaps surprising here, is the stark contrast of my findings with the work of Snoek (2017), in which Dutch start-ups had expressed a fear of sharing knowledge due to the competitive nature of the industry. However, this was not mentioned (and sometimes even disputed) in my cases - possible explanations are cultural differences, or strong IP support systems in France.

6.1.3. Inducement & Blocking Mechanisms

The third SQ within my research asked which factors either block or hinder the market introduction of CIs to the fashion and textile industry, to gain more insights into why CBSs engage in certain processes and interactions (and why they can't in others). Within the inducement mechanisms identified in my research, a strong innovative orientation within regions was important. This insight compares to empirical findings within other contexts - Le Feber and Smit (2023, p. 1889) also acknowledged the role of the region as a strong driver for innovation within the Swedish fashion industry: *"actors, networks, and resources tend to cluster into regions, and this concentration drives regional specialisations and entrepreneurial activity into certain technologies and industries"*. The significance of the latter is, to the best of my knowledge, still underrepresented in fashion literature. However, my findings do suggest that different CBS types (especially industrial vs. non-industrial CBSs) benefit from regional support structures in varying degrees - something not mentioned by Le Feber and Smit (2023). A possible explanation could be that different regions have

different 'regional orientations', as cited by Le Feber and Smit (2023). These regional orientations may cover certain technologies that are highly relevant to recycling CBSs, for example, but much less applicable to CBSs with other circular approaches. Nevertheless, the insight that regional specifications could be an underlying explanation of the varying support CBSs receive from the region, is a valid point of discussion.

My research finds that CBSs experience the changing regulatory landscape favouring the CE as a strong inducement mechanism, aligning with existing research such as Colombi and D'Itria (2023, p. 1), who state that *"the government is transforming from a mere controller to a facilitator of innovation synergies"*. While the literature often cites consumer demand for transparency and sustainable products as a major driver for adopting circular solutions (Abbate et al., 2023; Le Feber & Smit, 2023), this was less prevalent in my findings. Some CBSs noted growing consumer demand, but highlighted low willingness to pay and the relatively small size of customer segments interested in circular products. This difference could be due to the focus on CBSs, which are predominantly B2B-oriented and relatively young, resulting in limited direct contact with end users. Larger brands, with established customer bases, are more attuned to consumer demands and changes in purchasing behaviour. Contrarily, **brand demand** emerged as a significant driver for CI adoption in my research. Brand collaborations with CBSs can enhance interest from other brands, directly opposing Abbate et al. (2023), who found an absence of mimetic pressure among fashion brands. This discrepancy could be due to different empirical contexts, or the brand sizes studied within their sample.

A critical blocking mechanism identified for CBSs in the fashion and textile industry is the **digital/data gap**. Huynh (2021, p. 871) observe that *"in many industries, a digital transformation is co-occurring with the sustainability transition,"* and that digital technologies are essential to leverage CBMs (and vice versa). My research aligns with this view, revealing that CBSs have developed digital tools to enhance their BMs, as exemplified by [RE] PAIRE and Weturn. However, my study provides additional insights by highlighting the challenges posed by limited data availability in the fashion industry. CBSs often need to build their own databases, even when their BMs do not initially depend on them. They use this data to enhance their own business intelligence and decision-making processes. To the best of my knowledge, this generation of data by CBSs is an insight not prominently discussed in existing literature, underscoring the significance of the digital/data gap CBSs must overcome to succeed.

This data gap is recognised beyond the fashion industry, and was highlighted in the widely cited work by Kirchherr et al. (2018). However, it was not found to be a pressing barrier for the transition to a CE — Kircherr acknowledges their work presents a helicopter view of the CE transition, and differences might exist between sectors or BMs. My research provides insights into these differences at the BM (CI) level, within one sector. Although there is overlap between the identified inducement and blocking mechanisms in my work and Kircherr's CE barriers (e.g. hesitant company culture, lacking standardisation), a major addition from the perspective of the fashion industry is the sheer **lack of knowledge within the industry** on how to transition to the CE. This is important to consider, as it could further impede the hesitant attitude of brands and should encourage policymakers, ecosystem associations, and other industry bodies to continue CE education within the industry.

Brief Discussion on the TIS Approach

While not a specific SQ, it is relevant to briefly discuss the TIS approach used in this research. The inspiration for my research design comes from Planko et al. (2017), Gruenhagen et al. (2022), and Jansma et al. (2018), who demonstrated the value of an actor-oriented perspective within the TIS framework. Although Gruenhagen et al. (2022) provides a valuable list of system-level barriers, their analysis does not extend to the inducement and blocking mechanisms in relation to TIS functions. My research demonstrates that the TIS functional approach enables the analysis of these higher-level mechanisms, revealing new dimensions within the TIS framework: allowing the examination of inducement and blocking mechanisms while maintaining an actor-oriented perspective. This approach not only contributes methodologically, but also assists policymakers in identifying system-level aspects that need targeting to improve conditions for individual actors. However, a **critical reflection** reveals that the identified inducement and blocking mechanisms, while relevant for CBSs, may not necessarily apply to brands, consumers, or regions when adopting circular practices. Therefore, although this approach effectively addresses SQ 3, a comprehensive understanding of the inducement and blocking mechanisms faced by various industry actors in the transition to a CE requires similar analyses across different stakeholders.

6.2. Limitations

Although great care was taken to eliminate bias and ensuring rigour within this research, it does have its limitations - which I set out to identify in this Section. First, it is important to recognise the **limited generalisability** of this research: it focuses on a single sector in one geographical context, examining the perspectives of a relatively small group of actors within the French fashion industry. Hence, France's advanced regulatory environment may not be optimally reflective of other regions. While the findings could provide insights for other European contexts, particularly those with similar regulatory paths, the unique cultural and regulatory landscape in France means the results may not be directly transferable to other contexts. Nevertheless, the globalised nature of the fashion industry suggests some findings, e.g. those related to brand or manufacturer behaviour, may have broader applicability: for example, many manufacturers are in Asia, which does not change if you take French or Dutch CBSs as the unit of analysis.

Arguably the most significant limitation of my research is the **limited empirical base** on which the findings are based. Although 9 CBSs and 2 experts collaboratively provided a wide range of perspectives, it is not nearly enough to cover all perspectives within the empirical context of this study. First, it is most likely not the case the full spectrum of CBSs within the empirical context of this study is represented. The limited empirical base also resulted in the perspectives of (linear) incumbents, spinners, weavers, retailers and brands not being consulted. Although not the unit of analysis, these perspectives could have enriched the understanding of what drives or blocks brand interactions, for example. Aware of the data's limited scope, my research refrains from attempting to formulate new theories. Instead, it offers comprehensive, detailed empirical insights designed to enhance the understanding of the introduction of CIs.

In addition to the above, the **sampling bias** in my research poses limitations, as not all circular strategies or approaches were equally represented. This imbalance may have led to under-representation of value propositions, drivers, barriers, or processes associated with slowing or narrowing CBSs, as more closing CBSs were present in the sample. Hence, a more balanced sample could have yielded different results that could have, potentially, enabled me to distinguish drivers, barriers, interactions and processes based on CBSs' circular strategies. Furthermore, the CBS typologies I formulated for data analysis could have introduced bias: especially the distinction between industrial and non-industrial CBSs is not clear-cut, given the industrial nature of the fashion and textile industry's supply chains. Each CBS has varying degrees of industrial practices, and different views on this distinction could have affected the results. Furthermore, a **non-response bias** presents limitations to my research - from the almost 30 CBSs contacted, only 9 agreed to participate. As a result, it is possible that the sample over-represents certain types of CBSs, such as those more willing to share their practices or those with more positive outcomes. This limitation should be taken into account when interpreting the results. A non-response analysis was not conducted due to time constraints, and the openly accessible information on CBSs being limited.

Furthermore, although the fact that all **CBSs' names are published** within this research adds to the tangibility of my research, it also presents source of bias. Knowing their name would be in the research, CBSs might have responded differently to questions in comparison to if the CBSs remained anonymous. After careful consideration, the choice was made to include the CBSs' names: for their visibility, and to allow for a more in-depth description of their CIs and positions in the supply chain, which helps better understand their drivers, barriers, processes and interactions.

The data collection phase also posed limitations. Interviewees might have introduced **recall bias**, emphasising large milestones, leading to an under-representation of more routine processes and interactions that were important for market introduction of their CIs. Recall bias was reduced by creating the interview script such that it covered multiple types of processes, and asking follow-up questions to clarify the significance of certain events. On top of that, additional primary data sources were used to triangulate key information. Moreover, there were **imbalances in the amount of information** for each CBS due to varying ages and natures. To address this, a baseline of primary information was established through the interviews. Longer interviews were conducted with CBSs having less primary data available, to compensate.

Lastly, while the **functional TIS approach** proved useful, it may have introduced bias during data collection and analysis. Structuring the interview script around TIS functions could have led to certain processes and interactions being perceived as more significant, simply because questions linked to these TIS

functions were asked. This potential bias was mitigated by carefully observing how interviewees described events, and interviewees often indicated if a specific event was pivotal in their market introduction - special attention was given to these remarks to ensure an accurate representation of significant events.

6.3. Suggestions for Further Research

As discussed under 'Limitations,' the empirical context of this research limits this study's generalisability. Hence, replicating this study in **different countries**, both with and without favourable regulations for the CE, would be a valuable avenue for future research. Such studies could uncover similarities and differences across countries, providing valuable insights for policymakers on how to harmonise regulations to facilitate the widespread adoption of CIs. The latter could increasingly uncover overlapping TISs within the fashion industry, possibly gaining insights on potential synergies between innovative actors internationally. Furthermore, I would be particularly interested in replicating this study in countries where production is concentrated, as CIs that target the earlier supply chain stages would be predominantly applied there. This could offer valuable insights into the barriers to adoption faced by these parties and highlight the **social and societal impacts** of CI adoption. Since social injustice is unfortunately more prevalent among early supply chain actors, focusing on these stages could shed light on crucial issues and inform more effective CI design to improve social sustainability within the industry.

On Circular Value Creation and Capturing

Considering the findings from SQ1, further investigation into circular value propositions would be highly beneficial. Ranta et al. (2020) link the strategies of slowing, closing, and narrowing resource loops to different methods of creating value in a circular economy (CE). Given that many CBSs struggle to establish their business models, it would be valuable to explore existing or emerging value-capturing methods based on the circular value creation strategies described by Ranta et al. (2020). An interesting synthesis could be made by integrating these insights with the work of Nagano (2022, p. 1), who identified *"four value elements contributing to value propositions: environmental..., embedded social..., synergetic..., and educational value. These elements developed through various forms of interaction"*. This suggests that research on value propositions could be enriched by examining the processes and interactions that contribute to value elements - this would provide a comprehensive understanding of how CBSs can effectively capture and communicate value in a CE, forming a compelling avenue for further research.

On Circular Disruption

The results from SQ2 include a multitude of processes and activities, organised according to the TIS functions, that are essential for the market introduction of CIs in the fashion and textile industry. Based on these findings, another suggestion for further research is on the relatively novel topic of 'circular disruption,' coined by Blomsma et al. (2021, p. 1011): a *"transformation...which causes the systemic, widespread, and fast change from the harmful 'take-make-use-dispose' model to a socially and environmentally desirable and sustainable model...through the deployment of circular strategies"*. They operationalise the three stages of circular disruption according to the TIS functions and describe strategies to accelerate each stage of the **transition towards a circular paradigm**. Combining empirical insights from my research with those from other actors within the fashion industry within their framework would be highly useful to identify actions to facilitate the adoption of CIs from a broader, sociotechnical system perspective.

On CBSs' Niche Strategies

The results related to SQ 3 also present an intriguing foundation for further research. Ortt and Kamp (2022) developed a TIS framework to identify **niche strategies**[1] for individual actors introducing radically new innovations to the market. Using the the inducement and blocking mechanisms identified in my research, it would be interesting to use this framework to identify niche introduction strategies for CIs by CBSs in the fashion industry - I would be intrigued to see whether CBS niche strategies align with what is present in the literature, or that empirical research could uncover novel strategies. Another promising research direction could further explore the identified blocking mechanisms using the approach developed by De Oliveira et al. (2020), who propose a detailed examination of **causal pathways of systemic problems,** distinguishing between structural conditions and the activities they induce. Applying this framework empirically could clarify the interaction between actors and systemic issues in the fashion industry even further, providing deeper insights into the successive challenges that lead to system-level blocking mechanisms.

[1] Niche strategies focus on a small group of customers with specific wants and needs (DeBruyne et al., 2002)

07 Conclusion

Real-life examples, such as the bankruptcy of Renewcell, prove how difficult it is for CBSs to successfully introduce a CI to the fashion and textile industry, while the literature on the topic remains limited. To fill this literature gap, the aim of this research was to explore how CBSs introduce their CIs within the fashion and textile industry by combining empirical findings from a multiple-case study and drawing from theory on circular strategies in fashion, CIs, and the TIS functional approach. This Chapter presents the conclusions of this research. The research objectives and questions are revisited, the answer to the research questions are formulated, and the practical and theoretical implications of the findings are presented.

7.1. Research Questions

The main research question of this research was: *how do CBSs introduce their CIs to the fashion and textile industry?*. In short, the main research question can be answered as follows: **CBSs introduce their CIs through a combination of strategic positioning and diverse interactions and processes**.

Although the above answer is true, it does not sufficiently highlight the idiosyncrasies within the broad landscape of CBSs within the fashion industry. Even within my limited sample, CI and CBS characteristics result in variations in strategic positioning and pursued interactions and processes. While not all CBSs in the sample explicitly position their CIs as circular solutions, they communicate their impact by adhering to circular approaches (recycling, care & repair etc.). They use their **value propositions**, which include both tangible and intangible benefits, to communicate the added value and impact of their CI. To enter the market, the included CBSs seek **collaborations or pilot projects** with brands or suppliers. Essential interactions with brands, suppliers, ecosystem associations, and research centres help connect CBSs to the market, accelerate development, ensure proper market fit, and secure necessary resources. The specific combination of processes and interactions depends on the CBS's circular approach and typology, with key distinctions between industrial vs. non-industrial CBSs, those producing textiles, and those with digital tools. The sampled CBSs shape their interactions and processes to leverage key drivers and avoid barriers. Factors driving CI introduction are generally broad and non-sector-specific, enhancing overall innovation. In contrast, sector-specific factors primarily hinder market formation for CIs. Although the impact of driving or blocking mechanisms varies per CBS type, policy and regulatory support and ecosystem associations improve urgency amongst industry stakeholders. While data gaps, a lack of knowledge on the CE and slow decision-making processes present constant challenges. The above positioning, processes, interactions and driving and blocking mechanisms shape how the sampled CBSs navigate and introduce their CIs within the empirical context of the French fashion industry.

Sub-Research Questions

To provide a more detailed answer to the main research question, three SQs were formulated. The following subsections will restate these SQs and present the corresponding answers.

Circular Strategies and Value Propositions

The first objective of this research was to analyse how CBSs position their CIs within the fashion and textile industry, which led to the formulation of the first SQ: *how do CBSs position their CIs within the fashion and textile industry in terms of circular strategy and value proposition?* The results of my multiple-case study show that the sampled CBSs clearly pursue closing, slowing or narrowing strategies based on the functionality and impact of their CI. Although the sampled CBSs predominantly pursue a single circular strategy, the CBSs that produce garments or textiles are more so than the other CBSs positioned between the three strategies. This result highlights the need for circular considerations at the design stage, as these CBSs were found to be uniquely positioned to influence closing, slowing and narrowing of the garment or textile. An important finding is that not all sampled CBSs explicitly express their CI as being circular, while

their innovation can be seen as a contribution to the CE. Although the studied CBSs' strategies could be attributed to circular strategies, the more granular level of **circular approach** (recycling, care & repair etc.) is the primary means by which they communicate their positioning. This level of detail is how they identify and categorise themselves, and it is recognised and shared by industry stakeholders and experts.

For the successful introduction of CIs, it is essential that potential clients understand their benefits. The CBSs within my study communicate their value propositions openly through their websites to attract brands, investors, and other industry stakeholders. Although I found each CBS to have a unique value proposition tailored to the specific characteristics and target group of their CI, this research identifies common themes. First, the sampled CBSs' value propositions **extend beyond merely being circular solutions.** This suggests that for a CI to be adopted within the empirical context of my study, it must offer additional benefits beyond sustainability, even in an industry already under immense pressure to become more sustainable. Second, the sampled CBSs balance **tangible and intangible benefits** within their value propositions. Common tangible benefits include enabling operational efficiencies, enhancing transparency and traceability, and providing additional valorisation opportunities. Intangible benefits often involve enhancing the client's own value proposition and facilitating access to the CE.

CBS Processes and Interactions

The second objective of this research was to analyse how processes and interactions shaped the introduction of CIs by CBSs - leading to the second SQ being: *how do processes and interactions shape the market introduction of CIs by CBSs in the fashion and textile industry?* This SQ was addressed by linking empirically identified drivers, barriers, processes, and interactions using the functional TIS approach. The case studies revealed 96 drivers and 89 barriers, with overlaps between 22 drivers and 45 barriers from the literature review. While the empirically identified drivers and barriers varied between the CBSs depending on their circular strategy, approach and CI characteristics, key drivers included regulatory support, CE awareness, and collaborative co-creation, while major barriers involved a lack of traceability and transparency and difficulties in finding a business model. To answer SQ2, the identified drivers and barriers were linked to processes and interactions within the seven TIS functions. The findings are summarised as follows:

1. The sampled CBSs all conducted thorough **market research** to ensure market fit. The industrial CBSs prioritised meeting technical and regulatory standards, while the CBSs that develop solutions for consumers (textile and care & repair CBSs) additionally gauge market perceptions. Incubators, accelerators, and brand collaborations play crucial roles in providing information and access to experts which helps the sampled CBSs shape their CI to meet market demands. Challenges within these processes and interactions include managing internal processes, recruiting skilled employees, and developing profitable business models. Scaling up is essential for cost-competitiveness of the sampled CBSs, requiring continuous R&D to both scale up the CI and refine pricing strategies.
2. Evolving regulations, climate crisis urgency, and social pressure were found to drive demand for the studied CIs. **Regulatory changes** force brands to adopt CE practices, which all sampled CBSs recognise as a strong driver for CI market introduction and enables CBSs to increase the attractiveness of their CIs by offering regulatory compliance or exploiting governmental financial incentives.
3. The sampled CBSs often act as **knowledge brokers** by engaging in working groups, educating brands or panel discussions. The industrial CBSs focus on technical knowledge development and transfer in **collaborative research** projects with universities, industry partners or research centres to refine or test technologies and accelerate innovation. Digital tools used by CBSs generate valuable data for customers, or aiding in optimising waste streams and decision-making within CBSs.
4. For market introduction, the sampled CBSs raise awareness of their CIs by attending fairs, joining ecosystem associations, and leveraging regional/brand relationships. However, getting brands to commit was found to be challenging due to complex decision-making processes and limited CE know-how within the fashion industry. Offering free tests and using personal networks were found to incentivise adoption. Lastly, **implementation challenges** were highlighted by the majority of CBSs, and include adapting to diverse IT/workflow ecosystems and meeting production minima.
5. There were large variations in the ease of resource mobilisation between the sampled CBSs. Although the sampled CBSs all actively pursue **public and/or private funding**, public funding was found to be especially complex to navigate (and obtain) by some CBSs. Within the empirical context of

this research, private investments from VC and angel investors were found to be strongly driven when CBSs are linked to incubators and accelerators. Operational resources, such as feedstock and suitable facilities, are challenging to secure for all sampled CBSs- ecosystem organisations and regional support are crucial for obtaining these resources.

6. Key processes to **prove a CIs legitimacy** for the sampled CBSs includes creating demonstrators, proving impact, and obtaining industry recognition. Industrial CBSs focus on building demonstrators/prototypes to prove scalability and technical viability and conducting impact assessments to validate environmental benefits. Other CBSs do pilot projects to prove CI functionality. For the sampled CBSs, awards, eco-labels, and certifications help enhance legitimacy, but are not enough - they must be complemented by a viable BM to prove its maturity and profitability to investors.
7. Within the empirical context of this study, the **increasing amount of CBSs** is leading to stronger ecosystem associations, which increases visibility, stakeholder mobilisation, and policy influence. The proliferation of CIs was found to enhance circular literacy and validity of CBMs. Collaborations with brands improve supply chain transparency, benefiting the entire industry. Textile CBSs contribute to consumer awareness and market trends, while industrial CBSs drive technological advancements.

Although the above contribute to answering SQ2, the overarching conclusion is that internal processes, such as management, R&D and business development, and interactions with brands, research centres, suppliers, manufacturers and ecosystem associations are crucial in shaping how effectively the sampled CBSs introduce their CIs to the market. These interactions drive CBS visibility, legitimacy, resource mobilisation, market readiness, technological development, and industry-specific learning processes, ultimately determining the success of their market introduction efforts. The internal processes the sampled CBSs participate in are strongly adapted to these interactions, so that opportunities can be exploited, technologies can be scaled up and pilot projects/demonstrators/prototypes are successfully built.

Inducement and Blocking Mechanisms

The final SQ formulated to answer the main RQ was: *what factors drive or hinder the introduction of CIs by CBSs in the fashion and textile industry?* **6 inducement mechanisms and 6 blocking mechanisms** were identified within the empirical context of this research:

Blocking Mechanisms	Inducement Mechanisms
Data gap along supply chains and within brands' operations	Growing number and size of circular ecosystem associations
A hesitant, wait-and-see attitude and lack of commitment amongst brands and decision-makers	Strong regional commitment to local innovation and entrepreneurship
A lack of (internationally) harmonised standards	Strong collaborative R&D activity within the EU
Lack of knowledge of industry stakeholders on how to enter CE	Changing regulatory landscape in favour of the CE
Limited knowledge on the relationship between the investments versus the benefits of circular solutions	Increasing awareness of the CE and the negative effects of the fashion industry
Challenging landscape for public funding	Clustering of historical textile regions and iconic brands

Beyond identifying the inducement and blocking mechanisms, we can draw three meaningful conclusions from the findings. First, there is a notable distinction between the nature of these mechanisms. The majority of inducement mechanisms operate at the **macro level** and are generally not sector-specific. In contrast, most blocking mechanisms occur at the **meso level**, with four out of six being **sector-specific**. These findings suggest that broader policy and ecosystem developments facilitate CIs, while sector-specific issues present significant hurdles for their market introduction by the sampled CBSs. Second, the six inducement mechanisms collectively enhance all TIS functions, whereas blocking mechanisms primarily affect Market Formation. This suggests that while inducement mechanisms promote overall innovation, blocking mechanisms pose significant challenges to establishing a **viable market** for CIs. Third, the mechanisms' **impact varies among CBSs**. Regional support was found to be more beneficial for the sampled industrial CBSs, whereas data gaps mainly hinder CBSs with digital tools or those working with textile waste. However, the positive effects of ecosystem associations are widely acknowledged, as all CBSs within the case study find that they enhance their visibility and networking efforts, and present opportunities for collaborations.

7.2. Theoretical Implications

The theoretical implications of this research are threefold. First, this study enhances our understanding of the concepts of the CE, CBMs, and CIs. It provides an in-depth synthesis of the interconnections between CBMs, CBMIs, and CIs. The concept of CI is thoroughly analysed, compared to other related terms, and contextualised within the fashion and textile industry. These contributions significantly enrich the existing literature on circular solutions in fashion, aiding in the **standardisation and mainstreaming** of how CIs are perceived and acknowledged as essential components for the CE.

Second, this study provides valuable empirical insights into the processes and interactions that CBSs engage in during the market introduction of their CIs — a focal group that has been largely unexplored in the literature. This research **adds a critical new dimension** to the existing body of literature on the CE in the fashion industry, which has predominantly focused on CBMs and CBMIs. This research should emphasise and promote the importance of continuing to investigate CIs, especially since the literature consistently concludes how current technological gaps hinder the fashion industry's progress toward a CE.

Third, this research contributes to the growing body of literature on the **actor-oriented TIS functional approach**. Building on the work of Gruenhagen et al. (2022), Jansma et al. (2018), and Planko et al. (2017), I delved deeper into the drivers, barriers, and TIS processes at the intersection of the firm and the system level. This study not only provides additional evidence of the value of an actor-oriented perspective but also illustrates how connecting drivers, barriers, and TIS functional patterns can facilitate the identification of inducement and blocking mechanisms from an actor's viewpoint.

7.3. Practical & Social Implications

The research question of this study were deliberately chosen to ensure significant practical implications. By focusing on CBSs with technologically-driven CIs, this research aims to **increase awareness and literacy** within the fashion industry about these types of innovations, leading to greater acknowledgment and support for CBSs. Furthermore, the insights from this research can enhance **understanding of the innovations** developed by CBSs. This increased know-how can then help industry players recognise the value of CBSs' contributions. By learning that lengthy and complex decision-making processes severely impact CBSs, brands could be encouraged to streamline their decision-making by, for example, assigning a dedicated liaison within the brand to guide CBSs through internal processes. Additionally, analysing and comparing CBSs' value propositions can also provide valuable lessons. Other CBSs might discover overlooked benefits of their own CI, realising that the benefits extend beyond the stakeholders or consumers they initially had in mind. This could lead to a broader recognition of their impact and encourage (beginning) CBSs to communicate these benefits more effectively. On top of that, CBSs can learn from each other's experiences: **insights from their peers** can inspire and inform CBSs' strategies, fostering a more collaborative and supportive environment. Ecosystem associations or regional entities, in turn, can gain a deeper understanding of CBSs' challenges and strengths, motivating them to enhance their support mechanisms and address identified problem areas.

Furthermore, numerous insights within this research show how reducing toxic chemicals and increasing transparency, for example, can lead to better and safer work environments for employees along the supply chain. The practical implications of the latter include an increased awareness (and responsibility) towards acknowledging the **social and societal impacts of CIs**. Numerous CBSs within my research act as proof that it is well within the reach of consumers, brands and manufacturers to adopt solutions that will make their supply chains both more sustainable and ethical.

Just as resale platforms like Vinted and Vestiaire have become household names, I hope that this research will help CIs achieve similar recognition. In a few years, I envision consumers will be excited about wearing their **Iroony®** hemp trousers, dyed with **EverDye** pigments, paired with a durable **iNDUO®** shirt — each item registered and traceable with **itmatters'** smart tags. When clothes tear, **Prolong's** application will facilitate their repair, and when shoes need new soles, **[RE]PAIRE** will be the trusted solution. When sneakers reach their end of life, consumers will return them to stores for recycling by **THE 8 IMPACT**. Consumers will be excited about purchasing from brands known for recycling deadstock through **Weturn**, and mindful disposal of garments will support **Refact** or **Recyc'ELIT** in creating recycled fibres.

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A Case Study Protocol

A.1. Part A

The role of this protocol is to provide a **structured approach** to the conduction of the case study. As the overall research design outlines a multiple-case study, for which 8-10 startups will be the unit of analysis, each case must be conducted similarly to obtain meaningful results. First of all, the case study protocol helps me as a researcher stay focused on the main objective and purpose of the case study - this is achieved by formulating clear protocol questions. The protocol questions push me to construct my interview questions and secondary data research in such a way, that I should be able to answer all protocol questions. Secondly, the case protocol clearly outlines the data collection procedures. This helps me similarly conduct each case study, and plan for how each case will be conducted. By meticulously planning each interview or discussion, I will be able to avoid any potential clashes between case obligations.

As the topic of the introduction of CIs in fashion largely remains unexplored in academic literature, gaining empirical insights and building a tentative theory using an **abductive approach** is the chosen method to contribute to academic research. This Section aims to provide extensive background information on the case study, including the case study goals, research questions, theoretical framework and overall goal of the case study report.

This case study sheds light on the processes and dynamics behind introducing a CI to the fashion industry. Within this study, the **French CBS** is examined. The goals of this case study are:

1. To gain empirical insights on how CBSs experience the key processes surrounding the introduction of a CI in fashion.
2. To map the French startup environment of introducing CIs in fashion, through the perspective of the Technological Innovation System.
3. To identify important stakeholders for the introduction of CIs by French CBSs in fashion, and understand their relationship and how they interact.
4. To uncover underlying blocking or driving mechanisms to CI in the TIS.

To meet the aim of the case study, three case questions are formulated:

1. How does or has the CBS in question introduced their CI to the fashion industry?
2. Who are key stakeholders in the introduction of the CBSs CI, and how do they interact?
3. What are the main blocking and driving mechanisms for the CBS in introducing their CI to the French fashion sector?

Note that an in-depth exploration of the above questions can be read in Case Protocol Part C.

A.1.1. Theoretical Background 101

As the theoretical background of the overall research is elaborated on in-depth in Chapter 2, I will not repeat myself within this Section. However, I will provide a run-down of the most important concepts within this case study. The latter ensures that readers who scan through the Case Protocol without having read the theoretical background still understand the theoretical concepts, and thus understand the Case Protocol better.

Firstly, it is essential to understand the concept of a **Technological Innovation System** (TIS). A TIS can be described as "a network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion and utilisation of technology" (Carlsson & Stankiewicz, 1991, p. 49). A TIS consists of three main components,

being institutions, actors and networks. Analysing TISs, their main components and relationships between them, can provide firms, governments and non-profit organisations vital information on the direction of technological change within the chosen boundaries, and the speed of change. To explain how innovation systems function, we can map the activities within innovation systems that contribute to technological change. These activities are called functions, and they make up the **TIS functional approach,** as is used in this research. There are 7 functions, being: Knowledge Development and Diffusion, Influence on Direction of Search, Entrepreneurial Experimentation, Market Formation, Legitimisation, Resource Mobilisation and Development of Positive Externalities (Bergek, Jacobsson, et al., 2008; Hekkert et al., 2007).

Secondly, the term **Circular Innovation** (CI) is critical to understand. Closely related to the concept of eco-innovation, CIs describe a more specific niche of innovations. Eco-innovations can describe process, product, business model or service innovations, ranging from firm- to system-level innovations. CIs, in contrast, describe a single novelty of a technological nature, that contributes to closing, narrowing and slowing resource loops and thus contributes to the transition to a CE. Within the definition of a CI in fashion. two aspects are considered in particular to reflect the challenges and needs of the fashion industry: 1) circularity of the CI should be considered in the design stage, and 2) the ethicality and safety of CIs is paramount to ensure no vulnerable groups are exploited or endangered.

A.1.2. Philosophical Considerations

This case study takes the stance of **moderate constructionism** (MC). MC rejects the existence of a universal truth, but acknowledges that local, personal or community-based forms of truth exist (Järvensivu & Törnroos, 2010). In MC, it is believed these local truths can be understood through empirical observation, hence the explorative case study is an appropriate approach. Following this line of reasoning, within interviews, knowledge is jointly formed between interviewer and interviewee. Hence, semi-structured interviews are appropriate to leave room for the collaborative nature of creating knowledge.

Criteria for Assessment

In conducting case research, it is essential to consider its reliability, validity and generalisability. The first step I take to ensure sufficient **reliability** within my research is the meticulous documentation of the research process within this case study protocol. The more detailed the methodology is described, the better the method is repeatable over multiple cases. Secondly, the data analysis will be performed in a consistent way across all case studies (e.g. same coding protocol).

To ensure sufficient **validity,** the findings from the semi-structured interviews will be shared with the interviewees. The latter provides an opportunity to collaboratively reflect on the accuracy of the conclusions/findings I formulated based on what was discussed during the interviews. On top of that, Järvensivu and Törnroos (2010, p. 103) argue that to ensure validity, "the claims ... and chain or arguments linking them together are acceptable to the scientific community in light of critical reasoning and background assumptions". The literature review in Chapter 4 provides a solid set of assumptions on barriers and drivers within CI introduction in fashion, and can additionally be used as a form of triangulation of my own empirical findings. Next to my findings from the literature review, I plan to triangulate interviewee data by information on the internet and expert interviews.

As my case study targets a very specific type of firm that introduces a specific type of innovation, it must be acknowledged that the findings will never be generalisable for all firms or across industries. Järvensivu and Törnroos (2010) agree that generalisability for single- or multiple-case studies, but should be designed such that they contribute to contextual insights. And this is in line with an MC approach, since we don't aim to uncover the universal truth, but want to shed light on local truths. However, we can make sure a case study is sufficiently **transferable,** implying we can apply the same findings to similar contexts. For transferability, an in-depth understanding of the contextual factors must be developed before the case study. The latter involves studying prior empirical findings (Chapter 4), analysing the environment of the studied phenomenon (Chapter 2) and prior theoretical knowledge (Järvensivu & Törnroos, 2010).

A.2. Part B

Within Part B of the case study protocol, I will elaborate on how the fieldwork, i.e. data collection, will be organised for a case. Section A.2.2 elaborates on how informed consent is obtained for data collection.

A.2.1. Fieldwork

Members of the research team who were active in formulating and reviewing the case protocol were myself, Shea Haggerty, and first and second supervisors Dr. Hanieh Khodaei and Dr. Fátima Delgado Medina. All fieldwork for the case study is be conducted by me, Shea Haggerty (S.Haggerty@student.tudelft.nl). According to the case selection criteria outlined in Section 3.2.1 in Chapter 3, CBSs of interest were contacted. From the first point of contact, the data collection process can be described in the following, standardised steps:

1. The CBS in question is contacted either 1) via the contact information on their website, or 2) via direct message on LinkedIn. Once the CBS expresses interest in participating in the research, more information is provided to the CBS:
    - A description of the activities (hence time commitment) the CBS would engage in, if they agree to participate in the research. The activities comprise of a 60 min. interview, a request to review the interview transcript and potentially answer follow-up questions.
    - The Informed Consent Form
    - A general overview of the line of inquiry for the interview
    - An indication of when the interview would ideally take place (the week of 25th of March is communicated to all CBSs)
2. If the CBS requests it, an introductory meeting is held. This meeting is not recorded, nor is anything said in this interview used for data analysis. However, such a meeting can benefit the case study by creating a connection with the interviewee before the interview, explaining the objectives of the research, and discussing informed consent matters face-to-face. If the CBS does not wish to have such a meeting, the previously mentioned aspects are discussed via email.
3. A week before the communicated time indication for the interview, the point of contact within the CBS is emailed to schedule a time-slot for an interview. In this mail, the informed consent form is sent again if this is not signed yet, together with a list of general questions to give the interviewee a better feeling for the topics to be discussed in the interview. The exact interview script is not sent to avoid bias and to account for any last-minute changes to the script.
4. If the contact person agrees to a time-slot, the contact person is sent a Teams invitation (all interviews will be held via Teams) for the interview.
5. A semi-structured interview of approx. 60 minutes is held at the agreed-upon time-slot. A general list of questions (see Section A.3.1) is tailored to the specific CBS based on information on their website or news articles.

During the interview, a fully-charged laptop with a camera and earphones will be used to ensure proper sound quality. A second screen is used to enable note-taking, while still being able to see the interviewee. The interview is (with permission of the interviewee) recorded via the Teams application. After the interview, the interview is **transcribed** using the Teams transcription function. Before each interview, a test-run on Teams is done to ensure all functions work properly.

To ensure the interview is reported to its full extent, **notes** will be taken throughout. These notes can contain observations from the interviewer, or thoughts of the interviewee (e.g. potential follow-up questions for later in the interview). The interview notes also help to later on clarify any subjects that might not be recorded clearly.

Preparation before Fieldwork

Each interview requires thorough preparation, both regarding knowledge and practicalities. Knowledge-wise, the interviewer ensures that all available information regarding the start-up is read and understood. The interview script is tailored to ensure relevance to the start-ups position and innovation, and any additional questions that emerge during the grey literature search on the start-up are also noted. This way, the interviewees time is optimised as questions are avoided that could be answered by desk research.

Practically, the interview is prepared by making sure the interviewee has received a Teams invitation for the interview. At least half an hour before the interview, the laptop camera and audio are tested, and a test-run is done with the Teams audio recording and transcription functions to ensure they work well. The interviewer makes sure that the interview is conducted in a calm and quiet area (when conducted online). When conducted in person, the interviewer will, with consent of the interviewee, open a Teams meeting in the live interview setting to allow for convenient audio-recording and transcription of the interview. To make sure notes can be taken during the interviewer, the interviewer makes sure to have both pen and paper and a laptop to make notes on.

Accounting for Unexpected Events

During the case study, unexpected events might occur that hinder the original planning. For example, the interviewee might cancel, or the interviewer can fall ill. To account for these occurrences, timely communication with the contact person is vital. In case of a potential cancellation, I will aim to communicate this to the interviewee at least 24 hours before the interview. However, in some cases, this might not be possible. Then, the interviewee is sent an email explaining the situation as soon as possible.

Other unexpected events might me malfunctioning of technology during the interview (sound not working, laptop failure). In this case, a mobile phone will be used to quickly log into Teams and join the call from mobile phone on airplane more (to avoid the transcripts automatically being uploaded to the cloud). Although not ideal, this solution does allow for the continuation of the interview without significantly increasing the time commitment for the interviewee.

A.2.2. Informed Consent

Before the data collection (interview) takes place, informed consent must be obtained from the human subjects to be interviewed. To ensure a mutual understanding and agreement on what the interviewee consents to, an Informed Consent Form (ICF) is used. The IF is based on the standard IF template from the TU Delft, but tailored to reflect the specifics of this study.

It is important to note that for the case study, **two ICFs are formulated** depending on the preferences of the CBS in question. One ICF is suitable for CBSs who 1) wish to stay anonymous, or 2) would like the name of the CBS mentioned, but not have their personal data published in the study (see Figure A.1 for this ICF). The second ICF is suitable for CBSs who wish to have the name of the CBS mentioned, along with their contact details to allow any parties of interest to contact them (see Figure A.2 for the adapted parts, the initial pages are the same as ICF1). The approach of two different forms allows me to accommodate for specific wished of the CBSs included in the research, while at the same time ensuring a **standardised approach** to be applied to all cases. This approach was co-developed and approved by a data steward from the TU Delft. No data was collected before both the CBS and the researcher signed the ICF.

Figure A.1: Page 1 out of 4 of the Informed Consent Form. This page is the same for both ICF 1 and 2.

Informed Consent

Participation Research 'Circular is the New Black'

Delft University of Technology
Faculty of Technology, Policy and Management

You are being invited to participate in a research study titled `Circular is the New Black: the case of circular innovation in fashion'. The study is conducted by Shea Haggerty, under supervision of Dr. Hanieh Khodaei and Fatima Medina Delgado from the TU Delft, and external guidance is given by Dr. Benjamin Cabanes from MinesParis PSL.

The purpose of this research study is to gain empirical insights on the processes surrounding the introduction of circular innovation within the fashion industry by startups, and identifying the main barriers and drivers circular-born startups in the fashion industry endure when innovating towards circularity. To gain in-depth and industry-specific knowledge, we will be asking you to partake in an (online) interview, with a duration of approximately 60 minutes. The interview will focus on how company name experiences/experienced the development and introduction of their innovation, the important stakeholders during this process, and what processes and dynamics were important in the introduction and development of the innovation. The data will be used to create a holistic understanding of how startups launch circular innovations in the fashion industry, and what main drivers and barriers are in this process – this information currently forms a gap in the academic literature.

To the best of our ability, your answers in this study will remain confidential. Within this research, Dr. Benjamin Cabanes from MinesParis PSL will take on the role of external advisor, implying he will offer guidance and advice during the research, but will not access or view the participant data. We will ensure that only members of the TU Delft research team have access to participant data. All data is kept within the TU Delft, and not shared with MinesParis PSL or any other parties. We will refrain from collecting unnecessary personal data or otherwise sensitive information. The data will be stored on password-protected computers, on secure TU Delft cloud storage services with built-in encryption.

In this research study, you have the option to choose whether or not company name is disclosed in the final research. Your participation is entirely voluntary, and you can withdraw at any time. You are free to omit any questions you prefer not to answer. Furthermore, you have the discretion to withhold any information related to your company if you prefer. Your individual responses will be treated with confidentiality, and your identity, as well as the identity of your company, will not be disclosed without your explicit consent.

Within this research, Dr. Hanieh Khodaei fulfils the role of responsible researcher, and can be contacted at any time if you have any questions or concerns on H.Khodaei@tudelft.nl.

We thank you very much for your time and effort to participate in this research. By signing this consent agreement, you acknowledge that you have read and understood the terms of this consent agreement (and the explicit consent points on the following pages), and voluntarily agree to participate in the interview.

Figure A.2: Page 2 out of 4 of the Informed Consent Form. This page is the same for both ICF 1 and 2.

Explicit Consent Points

Please tick the appropriate boxes	Yes	No
A: General Agreement Research Goals, Participant Tasks and Voluntary Participation		
1. I have read and understood the study information dated 26-02-2024, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: • An audio-recorded online or in-person interview of approximately 60 minutes. The audio file will be transcribed to text. • The opportunity to review the transcription, to verify your responses and allow you to omit/change responses at your discretion. • Potential request for follow-up if any of the answers require further elaboration.	☐	☐
4. I understand that the study will end by 31 July 2024.	☐	☐
B: Potential Risks of Participating (incl. Data Protection)		
6. I understand that taking part in the study involves the following risks: (1) participation in this research being perceived as cumbersome, or conflicting with other obligations or priorities, and (2) unintended consequences from my responses, such as negative repercussions in my professional life because I participated in the research. I understand that these will be mitigated by: • Being provided clear and detailed information on the procedures and expected time commitment of the research upfront. • Being provided flexible participation options to accommodate my schedule and preferences (e.g. multiple time slots for interviews, ability to perform tasks asynchronously). • Being provided options as to which information will be shared in the research, such as company name, description, and the extent of the personal information being shared (e.g. role within company name) • Being provided the opportunity to check the transcription of the interview, and opt to omit any answers post-interview.	☐	☐
7. I understand that taking part in the study also involves collecting specific personally identifiable information (PII) (name, surname, email address) and associated personally identifiable research data (PIRD) (role and tenure at company name) with the potential risk of my identity being revealed. I understand risks for potential re-identification will be minimised by: • Restricting access to personally identifiable information to only the members of the TU Delft research team (Shea Haggerty, Dr. Hanieh Khodaei and Fatima Delgado Medina). • Aggregating the provided data to mask individual-level actions or contributions that could lead to re-identification.	☐	☐

Figure A.3: Page 3 out of 4 of the Informed Consent Form. This page is only included in ICF

8. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach: • The regularly updating of the researcher's operating system, software applications, and antivirus programs to patch known security vulnerabilities and protect against potential exploits. • The data will be stored on an internal TU Delft project storage during the research project. • Any PII will be removed or encrypted from research data before storing. • Access to research data will be restricted to solely the TU Delft research team. • Communication of the research data between researchers of the TU Delft research team will be minimised. In case of communicating the data, secure data transmission channels will be utilised.	☐	☐
9. I understand that personal information collected about me that can identify me, such as my name or the place where I live, will not be shared beyond the TU Delft research team.	☐	☐
10. I understand that the (identifiable) personal data I provide will be destroyed at the end of the research period, by at most the 31st of July.	☐	☐
C: Research Publication, Dissemination and Application		
11. I understand that after the research study, the information I provide could be used for possible outputs that may follow from the research. These possible outputs include reports, publications, website posts, and/or secondary use in the form of planned application in decision-making or service development.	☐	☐
12. I agree that my responses, views or other input can be quoted anonymously in research outputs. (anonymous) literal quotes will only be used in the research with my explicit approval.	☐	☐
13. I agree for company name to be mentioned in the research.	☐	☐
14. I agree for company name's pictures/company logos/additional materials to be included in public research outputs. Any additional material provided will remain entirely company name's ownership.	☐	☐
15. I agree for general details of company name to be mentioned in the research. These general details will consist of the following: • General description of company name, including company size and year of foundation. • General description of company name's innovation and/or field of technology. • General description of company name's place in the supply and/or value chain of the fashion industry	☐	☐
D: Long-term Data Storage, Access and Reuse		
16. I permit the anonymous interview data that I provide to be archived in the TU Delft education repository so it can be used for future research and learning.	☐	☐
17. I permit pseudonymised personal data to be stored on internal TU Delft project storage for at most 2 years after the research project, to account for potential publications or other follow-up research. After the 2 year period, it will be destroyed.	☐	☐

Figure A.4: Page 3 out of 4 of the Informed Consent Form. This page is only included in ICF

8. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach: • The regularly updating of the researcher's operating system, software applications, and antivirus programs to patch known security vulnerabilities and protect against potential exploits. • The data will be stored on an internal TU Delft project storage during the research project. • Any PII will be removed or encrypted from research data before storing. • Access to research data will be restricted to solely the TU Delft research team. • Communication of the research data between researchers of the TU Delft research team will be minimised. In case of communicating the data, secure data transmission channels will be utilised.	☐	☐
9. I understand that personal information collected about me that can identify me, such as my name or the place where I live, will not be shared beyond the TU Delft research team during the research.	☐	☐
10. I understand that the (identifiable) personal data I provide will be destroyed at the end of the research period, by at most the 31st of July.	☐	☐
C: Research Publication, Dissemination and Application		
11. I understand that after the research study, the information I provide could be used for possible outputs that may follow from the research. These possible outputs include reports, publications, website posts, and/or secondary use in the form of planned application in decision-making or service development.	☐	☐
12. I agree that my responses, views or other input can be quoted in research outputs. Literal quotes will only be used in the research with my explicit approval. I understand that I can choose (per quote) whether to be quoted anonymously.	☐	☐
13. I agree for company name to be mentioned in the research.	☐	☐
14. I agree that my personal information (including real name and contact information) will be mentioned in public research outputs.	☐	☐
15. I agree for company name's pictures/company logos/additional materials to be included in public research outputs. Any additional material provided will remain entirely company name's ownership.	☐	☐
16. I agree for general details of company name to be mentioned in the research. These general details will consist of the following: • General description of company name, including company size and year offoundation. • General description of company name's innovation and/or field of technology. • General description of company name's place in the supply and/or value chain ofthe fashion industry	☐	☐
D: Long-term Data Storage, Access and Reuse		
17. I permit my interview data, containing my real name and contact information, to be archived in the TUDelft education repository so it can be used for future research and learning.	☐	☐
18. I permit my personal data to be stored on internal TU Delft project storage for at most 2 years after the research project, to account for potential publications or other follow-up research. After the 2 years period, it will be destroyed.	☐	☐

Figure A.5: Page 4 out of 4 of the Informed Consent Form. This page is the same for both ICF 1 and 2.

Signatures

_____

Name of company

_____	_____	_____
Name of participant	Signature	Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Shea Haggerty	_____	_____
Researcher	Signature	Date

Study contact details for further information:

Shea Haggerty
S.Haggerty@student.tudelft.nl
Delft University of Technology

Dr. Hanieh Khodaei
H.Khodaei@tudelft.nl
Delft University of Technology

Ethical Considerations

As the cases involve interacting with human subjects, giving the ethical considerations of my research critical thought is essential. In order to safeguard the CBSs and the interviewee's rights and information, the following steps are adhered to:

- At no point in the case study was anyone involved deceived. All participants were informed beforehand on what they could expect during each stage of the case study.
- ICFs were used to communicate to the participants how their rights and information would be protected in the research. The ICFs also gave the CBS and the interviewee the choice of animosity.
- In all cases, data obtained from the interviews was stored on secure TU Delft databases. No interview data or personal information was communicated with anyone outside of the research team.
- All information that could lead to the identification of CBSs who wish to stay anonymous in the research is omitted in the data reporting stage.

For the case study, approval from the Human Research Ethics Committee of the TU Delft was obtained.

A.3. Part C

About the individual start-up, I want to reveal, either by internet searches or interview data:

- What is their CI, and how does it contribute to the CE?
- What is its potential impact?
- In what stage of development or introduction is the CI?

Other than gaining general knowledge about the nature and impact of the CI, I am interested in uncovering the processes and interactions the CBS has (had) when introducing their CI. Within this case study protocol, I list the questions for the researcher categorised per **TIS function.** Note that during the interview, such a distinction will not be made to avoid bias. The questions will largely overlap with the questions below, but will not be announced as being part of a TIS function, and will be tailored to the CBS in question. The questions below are based on the description of the TIS function by Hekkert et al. (2007) and Bergek, Jacobsson, et al. (2008), and the suggestions for ways to measure the TIS functions by Bergek, Jacobsson, et al. (2008).

- **Entrepreneurial Activities**
  - How does the start-up analyse and determine who is the right market for their innovation?
  - Did they have a specific market in mind when developing the innovation, and did this change once they tried to introduce the innovation?
  - What are the key learning processes the start-up went through about their innovation when introducing the innovation to the market?
  - Has the start-up changed or adapted its innovation after invention to better suit the market or potential customers? If so, how?
  - How did the start-up go about forming a link between your innovation in a technological sense, and its application and relevant customers?
  - What were the barriers and drivers in these learning processes as described above?
- **Knowledge Development & Diffusion**
  - Does the start-up have any patenting activity going on?
  - What does the start-ups R&D activity look like? What external/internal funding do they receive for their R&D projects?
  - What interactions does the start-up have regarding knowledge development? Do they do collaborative R&D with universities or research institutes?
  - What interactions does the start-up have regarding knowledge diffusion? Are they a part of knowledge networks? Do they contribute/take part in conferences or workshops?
  - What are the drivers and barriers for the start-ups regarding the activities described above?
  - How do you manage coordination along the supply chain for the application of your innovation? (additional question regarding coordination suggested by Planko et al. (2017))

- **Guidance of Search**
  - How do regulations or policies impact the direction of your start-up, or which customers you target?
  - How do social changes (e.g. increasing end-user interest in circular fashion) impact the direction of the start-up, which customers they target?
  - Has the start-up notices an increase or change in the interest by leading customers? What motivates them to work with a start-up, what motivates them not to?
  - Where does the start-up believe lies the biggest opportunity for growth potential, and how do they think they can reach it? Who do they need on board to reach it? What is the biggest barrier for them to reach it?
- **Market Formation**
  - In what market is the start-up currently selling its innovation? E.g. nursing, bridging or mass markets. How large is this market approximately, what is its geographical focus?
  - Within this market, is the demand profile clearly articulated, and who does this (Bergek, Jacobsson, et al., 2008)? Does the start-up have any role in this demand formulation?
  - How does the start-up go about creating demand for their product? What does the sales process look like?
  - Does the start-up notice how regulatory/policy changes affect the demand for their innovation?
  - According to the start-up, what are main drivers and barriers for creating a sustainable market for their innovation?
- **Resource Mobilisation**
  - How does the start-up go about raising enough financial capital?
  - Has the start-up raised capital for the development and introduction of their technology? How much, and by whom? Who were the key stakeholders in resource mobilisation processes?
  - Does the start-up encounter much competition for raising capital? Are there other barriers and drivers towards raising capital?
  - How does the start-up go about finding human capital? Does finding human capital in itself form a barrier or driver for the technology's introduction?
  - What are the main drivers and barriers in finding suitable employees for the start-up?
- **Creation of Legitimacy**
  - How does the start-up prove its technology's legitimacy to their surrounding TIS?
  - Who influences the legitimacy of the start-up's innovation? What does that interaction look like?
  - What does the start-up do to improve legitimacy of their innovation?
  - What are the drivers and barriers into proving the legitimacy of the start-ups innovation in fashion?
- **Development of positive externalities**
  - Does the start-up notice a difference in their customers' perception towards circular or sustainable solutions with the growing number of circular fashion start-ups?
  - Has their innovation, or the pooled innovations of circular fashion start-ups changed regulatory landscapes that they know of?
  - Has their innovation, or the pooled innovations of circular fashion start-ups changed the investment landscapes that they know of?

Within the interview and grey literature search for each case study, I aim to gain as much information on the seven TIS functions as possible, trying to answer as many possible of the questions listed above. These questions are already written to reflect the actor-oriented perspective my research takes. However, to even better grasp the role of the CBS within the fashion TIS, I aim to answer these **final three questions** within each case, raised by Van de Ven (1993) and Hekkert et al. (2007):

- Which functions will the CBS perform?
- Which organisations should the CBS link to, to perform other functions?
- Which organisations will the CBS compete with on certain functions?

A.3.1. Interview Protocol

In this Subsection, I present the general version of the interview protocol (i.e. script) I used for my research. These interview questions are representative of the overall line of inquiry adhered to in all interviews. However, **each interview script is tailored** to the specific innovation and situation of the CBS. Since some start-ups wished to remain anonymous, the tailored scripts are not made public, as they could reveal information that could risk the identification of the start-up in question.

At the start of the interview, a short introduction round is held when prior communication is only been conducted via email. Each interview begins with me reiterating the aim of my research, and the approximate length of the interview. I ask whether the interviewee is still in accord and aware of the contents of the Informed Consent Form. Finally, I ask the interviewee whether it is okay to record the interview before starting with my questions.

As the interviews are **semi-structured,** I adhere to a maximum of 12 questions to leave sufficient room (approx. 5 min. per question) for exploring any emerging topics and to allow the interviewee to provide in-depth elaborations. Below, you can find the interview script. Note that all questions in bullet-points are potential follow-up questions that can be asked if the interviewee gives short answers, or to steer the discussion more. In case the innovation is not clearly articulated on the CBSs website, the interview will start with the question if the interviewee can briefly explain the technological innovation of X[1] in their own words. After, the following script will be adhered to:

1. In what phase is X currently with its innovation? (if needed, give the interviewee options to choose from: 1) development phase, 2) established technology, no commercialisation, 3) early stage commercialisation, 4) advanced commercialisation).
    - From your perspective, how does X's innovation impact the circular economy, specifically for the fashion industry? How do you view the potential impact of your innovation?
2. Who is currently X's target market? Within this market, what determines the demand for your innovation?
    - Did you have a specific market in mind during the development of your innovation, and did this change when you introduced the innovation to the market?
    - Did you change anything about your innovation in particular in the process of introducing it to the market? What caused this change?
3. How did you shape your business model to leverage your circular innovation? Did you change anything about your business model throughout market introduction?
4. What were the key learning processes you went through when introducing the innovation to the market?
5. What motivated your main customers to collaborate with X? Were there any challenges for them to overcome to collaborate with you?
6. How do you manage coordination along the supply chain for the introduction and application of your innovation?
7. How is the Intellectual Property (IP) of your innovation regulated? In case of patenting: how was the process of patenting your innovation?
    - Was a patent necessary before market entry?
    - Have IP issues ever stopped X from engaging in specific projects or networks?
    - How does X demonstrate the legitimacy of your innovation within the fashion industry?
    - Could you name the key influencers affecting the legitimacy of your innovation, and how do you engage with them?
8. How would you describe X's R&D activities, and what funding sources do you rely on for these projects?
    - Do you have any collaborations for R&D projects? How did the collaboration come to be? (specific collaborations will be asked about if relevant for CBS in question).

[1] The CBS in question will be referred to as X within this Section

- How does your startup address the process of finding and attracting suitable employees? Has (or is) human capital been a barrier towards growth and introducing your innovation to the market?

9. Does X interact in any knowledge networks? If yes, in what way?
    - What factors play a role in the decision to join such a network?
    - How do these knowledge networks help X in introducing your innovation?
10. Do regulations or government policies influence X's strategies or processes? If so, in what way?
    - Have you observed any changes in customer interest or preferences due to social shifts toward circularity in fashion?
    - Have you noticed any positive or negative effects following from the increasing amount of circularity-oriented start-ups in the fashion industry?
    - Are you aware of any regulatory or investment landscape changes influenced by your innovation or that of other circular start-ups?
11. What strategies does X employ to raise financial capital?
    - Who are important stakeholders in raising financial capital, how did X find them, and how do you interact?
    - Were there any significant barriers for X when raising capital? Were there strategies, stakeholders or other connections that helped you?
12. Where do you think the biggest growth potential and challenge lies for X? How do you think you can exploit and conquer them, who can help you?

The interview ends when all questions are answered, or the time is up. In case of not all questions being answered within 60 minutes, the interviewee is asked whether it would be alright to extend the interview. If not, the interview ends. The interviewee is thanked for their cooperation, and the **follow-up steps** are reiterated. These include:

- A follow-up email with the **transcription of the interview,** to be reviewed by the interviewee. The interviewee has the opportunity to add to the transcript or to omit any answers given.
- The question whether the interviewee is open to receiving any follow-up questions per mail.
- The notification that any direct quotes will only be included with explicit approval of the interviewee.
- The question whether they would like to receive the research upon completion.

A.4. Part D

This Section will provide an **outline of the report** of the case study, along with the extent of documentation accompanying the case study report. The case study is aimed at an audience with an interest in the circular economy and fashion industry, but no prior knowledge of either topic is required to understand and be able to identify the key takeaways from each case. The latter is enabled by creating a flowing, storytelling-like case description, containing elaborate explanations (if the consent is obtained from the start-up to share these details) on the start-ups innovation, challenges, drivers, processes and collaborations. Even though the TIS functions are used to structure the analysis and to make the findings relevant to TIS literature, no specific knowledge on TIS functions is necessary to understand the conclusions. However, former knowledge on innovation systems might benefit the reader to grasp the collaborative extent of innovation, and it might help place this study better in the overall context of the fashion industry.

Each case study will be presented in 2-3 pages. Within these pages, the following elements will be included:

1. A description of the start-up, including year of foundation, number of employees, geographical location, etc.
2. A description of the circular innovation of the start-up, including any specific technologies used, the CI classification for fashion (see Table 2.1), the level of novelty of the innovation, etc.

3. A description of how the start-up was recruited for this research, and how the communication went. If agreed upon with the start-up, a description (role, tenure at start-up, short background, name) of the interviewee will be shared.
4. Per TIS function, a flowing story containing information obtained via the semi-structured interview and the desk research.
5. Any anecdotes or standout findings will be shared in the case study report.

Note that it might not be possible to include all of the above, due to anonymity reasons or due to the information not being successfully obtained in the interview and desk research. If this is the case, it will be explicitly mentioned in the case report.

Appendix B

B.1. Drivers and Barriers

This Section includes all the drivers and barriers identified within the literature review. All drivers and barriers were given an ID, which enabled me to link them to empirically identified drivers and barriers, which constitutes the pattern matching that was conducted. Table B.1 and B.2 showcase the drivers and barriers from the literature review, respectively. Note that the tables might span multiple pages.

Table B.1: The list of drivers for introducing circular innovations by fashion startups, synthesised from the selected articles.

ID	Subject	Driver	References
		Technological Drivers	
LR.D1	Internal	Technological solutions can help scale current businesses for efficiencies	Todeschini et al. (2017)
LR.D2	External	Emerging reverse logistics in fashion stimulates the need for digital technologies	Todeschini et al. (2017)
LR.D3	External	Growing competition in recycling pushes firms to innovate for efficiencies to keep costs low	Baltussen (2019), Ninnimäki (2018), and Turnbull et al. (2021)
		Market and Economical Drivers	
LR.D4	Internal	Circular Innovations can lead to competitive advantage	European Commission (2019) and Le Feber and Smit (2023)
LR.D5	Internal	Knowing impact of innovation and where it stands in supply chains	Le Feber and Smit (2023)
LR.D6	External	Growing number of sustainability and circularity-oriented customers	Ballie and Woods (2015), Baltussen (2019), European Commission (2019), Le Feber and Smit (2023), Snoek (2017), Ten Napel (2024), and Turnbull et al. (2021)
		Operational and Organisational Drivers	
LR.D7	Internal	Start-ups have internal operations programmed towards CE from the start, as opposed to linear incumbents who might experience path-dependency	European Commission (2019) and Snoek (2017)
LR.D8	Internal	Partnerships and collaborations can enhance negotiation position of start-ups within suppliers and manufacturers	Fashion for Change (2021), Le Feber and Smit (2023), and Snoek (2017)
LR.D9	External	Personalised support/community training drives acceptance of technology	Luján-Ornelas et al. (2020)
LR.D10	External	Mobilising stakeholders via networks and collaborations can enable the introduction of larger, more radical innovations	Ballie and Woods (2015), Ellen Macarthur Foundation and Circular Fibres Initiative (2017), Fashion for Change (2021), FashNerd (2024), and Lommerse and Loots (2022)
		Social and Cultural Drivers	
LR.D11	Internal	Personal motivation to contribute to circularity in fashion amongst founders	Le Feber and Smit (2023) and Snoek (2017)
LR.D12	Internal	Circular innovations enhance consumer demand by raising awareness for CE	Le Feber and Smit (2023)
LR.D13	Internal	Start-up's embeddedness in social networks drives introduction of innovation	Le Feber and Smit (2023)
LR.D14	External	Growing acceptance recycled materials	Baltussen (2019) and Turnbull et al. (2021)
LR.D15	External	Growing awareness for environmental and ethical issues of fast fashion among consumers	Baltussen (2019), European Commission (2019), Le Feber and Smit (2023), Piller (2023), and Snoek (2017)
LR.D16	External	Growing interest in CE principles within fashion industry	Baltussen (2019), Le Feber and Smit (2023), Ninnimäki (2018), Piller (2023), and Turnbull et al. (2021)
		Financial Drivers	
LR.D17	External	Potential incentives for CE businesses, e.g. tax benefits for circular companies	Fashion for Change (2021)
LR.D18	External	Pooled financial support for CE innovations and R&D	Baltussen (2019), European Commission (2019), Lommerse and Loots (2022), Snoek (2017), and Ten Napel (2024)

ID	Subject	Driver	References
		Regulatory and Policy Drivers	
LR.D19	Internal	Radical innovations can receive heightened support from governments due to potential for system-wide change	Lommerse and Loots (2022)
LR.D20	Internal	Engaging with extra-regional levels drives changes in supply chain practices	Le Feber and Smit (2023)
LR.D21	External	External pressures from NGOs can pressure firms to take more measures regarding the CE	Baltussen (2019) and Fashion for Change (2021)
LR.D22	External	Policies and regulations can force organisations to seek circular solutions	Ellen Macarthur Foundation and Circular Fibres Initiative (2017), European Commission (2019), Fashion for Change (2021), FashNerd (2024), Le Feber and Smit (2023), Luján-Ornelas et al. (2020), Piller (2023), Ten Napel (2024), Todeschini et al. (2017), and Turnbull et al. (2021)
LR.D23	External	Sustainability/eco-labels can create demand for CE solutions	Fashion for Change (2021) and Luján-Ornelas et al. (2020)
		Knowledge and Information Drivers	
LR.D24	Internal	Start-ups have unique expertise and can be valuable to larger firms, e.g. by consulting them	Todeschini et al. (2017)
LR.D25	Internal	Knowing your value and supply chain makes it easier to design and implement circular solution	Le Feber and Smit (2023)
LR.D26	Internal	Start-ups flexible and open culture stimulates sharing of information, which enhances knowledge development	European Commission (2019) and Le Feber and Smit (2023)
LR.D27	External	Collaboration stimulates the co-creation of innovations	Ballie and Woods (2015), European Commission (2019), Fashion for Change (2021), and Le Feber and Smit (2023)
LR.D28	External	Geographical proximity to other innovative parties drives knowledge co-creation	Le Feber and Smit (2023) and Lommerse and Loots (2022)
LR.D29	External	Accelerator and capacity building programmes for start-ups in fashion can stimulate development and introduction of innovations	European Commission (2019) and Fashion for Change (2021)
LR.D30	External	Engaging with other parties enhances learning processes and the diffusion of tacit knowledge	Le Feber and Smit (2023)

Table B.2: The list of barriers for introducing circular innovations by fashion startups, synthesised from the selected articles.

ID	Subject	Barrier	References
		Regulatory and Policy Barriers	
LR.B44	Internal	Costly and lengthy to apply for governmental or other eco-labels	Fashion for Change (2021) and Snoek (2017)
LR.B45	External	Traceability and transparency not guaranteed and difficult to establish	Baltussen (2019), Ellen Macarthur Foundation and Circular Fibres Initiative (2017), Fashion for Change (2021), Luján-Ornelas et al. (2020), and Ninnimäki (2018)
LR.B46	External	Lack of industry-specific, harmonised regulatory policies	Ellen Macarthur Foundation and Circular Fibres Initiative (2017), European Commission (2019), Fashion for Change (2021), Luján-Ornelas et al. (2020), Piller (2023), Snoek (2017), Ten Napel (2024), and Turnbull et al. (2021)

ID	Subject	Barrier	References
		Social and cultural barriers	
LR.B1	Internal	Difficult to build network within fashion industry	Almanza and Van den Berg (2016) and European Commission (2019)
LR.B2	External	Hard to align CE values along value chain	Todeschini et al. (2017)
LR.B3	External	CE unawareness amongst customers	Baltussen (2019), European Commission (2019), Fashion for Change (2021), FashNerd (2024), Snoek (2017), and Turnbull et al. (2021)
LR.B4	External	Lacking education within industry towards CE	Lommerse and Loots (2022), Luján-Ornelas et al. (2020), Piller (2023), and Ten Napel (2024)
LR.B5	External	Industry has slow response to CE and sustainability	Fashion for Change (2021), FashNerd (2024), Lommerse and Loots (2022), and Ten Napel (2024)
LR.B6	External	Many businesses don't see waste as a resource	Baltussen (2019) and European Commission (2019)
LR.B7	External	Negative perception towards recycled or repurposed materials or products	Fashion for Change (2021), FashNerd (2024), Lommerse and Loots (2022), Ten Napel (2024), and Turnbull et al. (2021)
		Technological Barriers	
LR.B8	Internal	Technological feasibility of scaling up technology is low	Baltussen (2019)
LR.B9	Internal	Technology not well enough developed for industry quality demands	Ellen Macarthur Foundation and Circular Fibres Initiative (2017), European Commission (2019), Piller (2023), and Snoek (2017)
LR.B10	Internal	Consistency of quality of technological outputs (i.e. materials) not consistent in beginning	Baltussen (2019), Fashion for Change (2021), Lommerse and Loots (2022), and Turnbull et al. (2021)
LR.B11	Internal	Technological process can be lengthy	Le Feber and Smit (2023) and Lommerse and Loots (2022)
LR.B12	External	No open access to intermediate technologies	Lommerse and Loots (2022)
LR.B13	External	Textile blends block many recycling or sorting technologies	Baltussen (2019), Luján-Ornelas et al. (2020), and Ninnimäki (2018)
		Market and Economical Barriers	
LR.B14	Internal	Challenging to identify target group for innovation	Almanza and Van den Berg (2016)
LR.B15	Internal	Difficult to establish competitive advantage	Baltussen (2019), European Commission (2019), Fashion for Change (2021), and Todeschini et al. (2017)
LR.B16	Internal	Lack of focus on market development due to heavy technological focus	Lommerse and Loots (2022)
LR.B17	Internal	Trends and seasonality in fashion industry complicate integration of innovative technology	FashNerd (2024)
LR.B18	Internal	Difficult to prove impact of innovation to potential customers and partners	FashNerd (2024)
LR.B19	External	Lack of demand for recycled materials	Le Feber and Smit (2023) and Ninnimäki (2018)
LR.B20	External	Unfair competition due to cheaper fast fashion manufacturers and retailers	European Commission (2019), Fashion for Change (2021), and FashNerd (2024)
LR.B21	External	Misalignment between industry's actions and CE principles, fear of venturing into the unknown	Ten Napel (2024)
LR.B22	External	Linear incumbents don't see circularity as a strategic priority	Snoek (2017) and Todeschini et al. (2017)
LR.B23	External	Defensive investment strategies by large players block wide-scale adoption	Almanza and Van den Berg (2016) and Snoek (2017)
LR.B24	External	Fashion industry biased towards short-term thinking (i.e. returns) over long-term benefits. No long-term commitment	FashNerd (2024), Snoek (2017), Ten Napel (2024), and Turnbull et al. (2021)
LR.B25	External	Price for consumers often higher for circular products	Almanza and Van den Berg (2016), Baltussen (2019), European Commission (2019), Fashion for Change (2021), Piller (2023), and Turnbull et al. (2021)
LR.B26	External	Increased competition in collecting and recycling practices	European Commission (2019) and Ninnimäki (2018)

ID	Subject	Barrier	References
		Financial Barriers	
LR.B27	Internal	Investing in R&D and sales at the same time is almost impossible	Snoek (2017)
LR.B28	Internal	Economic feasibility of scaling up technology is low	Baltussen (2019), European Commission (2019), and Fashion for Change (2021)
LR.B29	Internal	Revenue only when technology is fully functional	Almanza and Van den Berg (2016), Baltussen (2019), FashNerd (2024), and Snoek (2017)
LR.B30	Internal	High technology installation costs/upfront capital	Almanza and Van den Berg (2016), Baltussen (2019), FashNerd (2024), Snoek (2017), and Ten Napel (2024)
LR.B31	Internal	Start-ups don't have strong business case developed for CI	Ballie and Woods (2015), Lommerse and Loots (2022), and Snoek (2017)
LR.B32	External	Lack of access to financing	European Commission (2019), Fashion for Change (2021), and Ten Napel (2024)
		Organisational and Operational Barriers	
LR.B33	Internal	Difficulties in managing start-up	Almanza and Van den Berg (2016) and Fashion for Change (2021)
LR.B34	Internal	Challenging to create visibility amongst consumers and stakeholders	Almanza and Van den Berg (2016) and European Commission (2019)
LR.B35	Internal	Weak negotiation position with manufacturers and suppliers	Almanza and Van den Berg (2016) and Snoek (2017)
LR.B36	Internal	Finding the right partners is difficult	Fashion for Change (2021) and Snoek (2017)
LR.B37	External	Traceability and transparency along value chain needed to properly implement circular innovation	Baltussen (2019), Ellen Macarthur Foundation and Circular Fibres Initiative (2017), European Commission (2019), Fashion for Change (2021), Luján-Ornelas et al. (2020), and Ninnimäki (2018)
LR.B38	External	Cooperation with multiple stakeholders in value chain is difficult	Almanza and Van den Berg (2016), Ballie and Woods (2015), Baltussen (2019), European Commission (2019), Fashion for Change (2021), Luján-Ornelas et al. (2020), Ten Napel (2024), Todeschini et al. (2017), and Turnbull et al. (2021)
LR.B39	External	Complex supply and value chain	Almanza and Van den Berg (2016), Baltussen (2019), Fashion for Change (2021), Luján-Ornelas et al. (2020), Todeschini et al. (2017), and Turnbull et al. (2021)
LR.B40	External	Lack of supporting infrastructure to leverage technology	Baltussen (2019), Ellen Macarthur Foundation and Circular Fibres Initiative (2017), Fashion for Change (2021), Luján-Ornelas et al. (2020), Piller (2023), Snoek (2017), Ten Napel (2024), and Turnbull et al. (2021)
LR.B41	External	Lack of production or development facilities for start-ups	Ballie and Woods (2015) and Lommerse and Loots (2022)
LR.B42	External	Manufacturers' production minima are difficult to reach for start-ups	Almanza and Van den Berg (2016), Ballie and Woods (2015), Baltussen (2019), European Commission (2019), Fashion for Change (2021), Piller (2023), and Snoek (2017)
LR.B43	External	Uncertain demand makes it challenging to manage inventory	Snoek (2017) and Turnbull et al. (2021)
		Information and Knowledge Barriers	
LR.B47	Internal	Difficult to measure impact (LCA) of innovation	Fashion for Change (2021) and FashNerd (2024)
LR.B48	Internal	Design for circularity more complicated than status quo	Fashion for Change (2021) and Todeschini et al. (2017)
LR.B49	Internal	If start-up is frontrunner with technology, difficult to benefit from spillover effects	Lommerse and Loots (2022)
LR.B50	Internal	Fear of sharing proprietary knowledge due to IP concerns	Baltussen (2019) and Snoek (2017)
LR.B51	Internal	Social capital (expertise, experience) hard to obtain	Almanza and Van den Berg (2016), FashNerd (2024), Piller (2023), and Snoek (2017)
LR.B52	External	Little and scattered knowledge and tools available for SMEs in fashion	Ellen Macarthur Foundation and Circular Fibres Initiative (2017), European Commission (2019), Fashion for Change (2021), and Luján-Ornelas et al. (2020)
LR.B53	External	Secrecy within supply chains in the fashion industry to protect competitive advantage	Almanza and Van den Berg (2016) and Snoek (2017)

B.2. Empirically Found Drivers and Barriers

This Section includes all the drivers and barriers identified empirically within the case studies. Table B.3 and B.4 showcase the drivers and barriers from the case studies, respectively. If a driver or barrier matched up with a driver or barrier from the literature review, the ID from the literature review driver/barrier is shown in the right column of Tables B.3 and B.4. Note that the tables might span multiple pages.

B.2.1. Drivers

Table B.3: The empirically identified drivers and correlating drivers from the Literature Review (LR).

Context	Driver	Match LR
	Technological Drivers	
Internal	Innovation tailored to industry specs	
Internal	Innovation is operable with different IT ecosystems	
Internal	Innovation addresses more than one material	
Internal	Demonstrators/prototypes enhance technology's legitimacy	
Internal	Demonstrators/prototypes can help shape scaling-up roadmap	
Internal	Technology compatible with existing infrastructure	
Internal	Innovation aids brands in digital transformation	LR.D2
External	Luxury brands' textiles more straightforward to recycle	
External	Digital technology gaining popularity to trace/manage products	LR.D2
	Market & Economy Drivers	
Internal	Added value of innovation extends beyond CSR	
Internal	Properly addressing customer painpoints	
Internal	Visibility amongst consumers	
Internal	Awards enhance visibility and legitimacy	
Internal	Ability to prove that innovation adds value	LR.D25
Internal	B2B-oriented innovation less subject to seasonality than B2C	
Internal	In-depth knowledge of fashion ecosystem	LR.D20
External	Collab opens up doors to their customers/partners	
External	Competitors can validate business model	
External	Need to address complex textile blends	
External	Brands can enhance marketing/visibility	
External	Association with region drives visibility	
External	Incubators add legitimacy and visibility to start-up	
External	Increasing consumer demand for circular/sustainable products	LR.D4, LR.D5
External	Ecosystem associations enhance start-ups' visibility	
External	Regions facilitate access to EU markets and projects	
External	Authenticity issues in fashion require solutions	
External	Brands must find solutions for what they put on the market	
External	Luxury brand collabs greatly enhance legitimacy	
External	Collabs with brands spark interest from other brands	
	Operational & Organisational Drivers	
Internal	Applying to project/funding calls structures internal workflows	
Internal	Start-up's agility allows for quick response to changing environment	LR.D21
External	Ecosystem associations fund/manage (over sorting) waste streams	
External	Access to equipment/machinery via collaborations/partnerships	
External	Proximity to France's historical brands/textile regions	LR.D23
External	Region facilitates collaboration with technology provider	
External	Consortia along value chain can drive/align collaborative projects	LR.D8
External	Access to (industrial) machinery via partnerships/collabs	
External	Access to homogeneous waste/feedstock	
External	Brand pushes start-up to have clear (industry-specific) roadmap	
External	Synergies with other players, e.g. using byproducts/services	
External	Region assists in finding location/plant for start-up	
External	Brands tailoring expectations to match start-ups's capacity	
External	Proximity to actors in circular ecosystem	
External	Brands can catalyse action in supply chain in collaboration	LR.D7
External	Personalised support	LR.D9
External	Collaborations can open up access to talent pool	

Context	Driver	Match LR
	Social & Societal Drivers	
Internal	Circular solutions can enhance customer engagement	
Internal	Founding team intrinsically motivated to contribute to CE	LR.D9
Internal	Proven track record in the industry enhances trust/legitimacy	
Internal	Personal network drives legitimacy	LR.D13
Internal	Trust between parties enhances willingness	
External	Brands gradually integrating environmental cost in decision-making	
External	Collaborations drive long-term partnerships	
External	Communication and interaction with other CE actors	
External	Increased awareness for the CE	LR.D12
External	Brands already engaged with CE more likely to collaborate	
External	Brands pushed to engage in CE for reputation/social pressure	LR.D16
External	Ecosystem associations drive networking and access to experts	
External	Project calls drive networking	
External	Incubators drive connections and networking	LR.D29
	Financial Drivers	
Internal	Innovation has fit with funding calls	
Internal	Scaling up drives costs down	
External	Public funding drives private funding	
External	Long-term perspective within partnerships	
External	Public funds willing to invest in risky R&D	LR.D15, LR.D19
External	Collabs with luxury brands provide more revenue	
External	Emergence of financial incentives to engage in circular practices	LR.D13
External	Incubators can drive/assist with private investments	LR.D24
External	Regional innovation initiatives/funds	LR.D14, LR.D18
	Policy & Regulatory Drivers	
Internal	Innovation is fully traceable	
External	Regulatory compliance is part of value proposition	
Internal	Obtaining industry-wide certficiation/recognition	
External	Regulations changing in favour of the CE	LR.D22
Internal	Being engaged on local, regional and national level	LR.D20
External	Support from policy makers	
External	The Repair Bonus	
	Information & Knowledge Drivers	
Internal	Start-up's unique knowledge	LR.D24
Internal	Applying to project/funding calls drives internal R&D	
Internal	Strong R&D capabilities	
Internal	Outsourching R&D to research centres can speed up development	
Internal	Patents allow for clear communicative tools in brand/partner collaborations	
Internal	Meeting with suppliers/manufacturers 'in the field'	LR.D30
External	Benefit from experience and know-how through collaboration	LR.D30
External	Fairs/conferences drive learning and opportunity identification	
External	Ecosystem associations can provide strategic advice	
External	Brands' increasing know-how on materials facilitates communication surrounding innovation	
External	Ecosystem associations can assess/provide feedback for innovation	
External	Competitors can help educate the market on circularity	
External	Project/synergies with other circular start-ups	LR.D22
External	Industry reports/studies drive awareness and action	
External	Collaborations drives co-creation of innovation	LR.D22, LR.D27
External	Access to supply chain specs/information via brand collaborations	LR.D30
External	Collaboration enhances eco-conception of circular products	LR.D10
External	Collaborations allow start-ups to understand which materials are used	

B.2.2. Barriers

Table B.4: The empirically identified barriers and correlating barriers from the Literature Review (LR).

Context	Barrier	Match LR
	Technological Barriers	
Internal	Challenging to produce consistent quality	LR.B10
Internal	Design for CE is challenging	LR.B48
Internal	R&D taking longer than expected	
Internal	Challenging to prove scalability of technology	LR.B8
External	Complex textile blends difficult to address	LR.B13
External	Digital/data gap along supply chain, making it difficult for start-ups to implement or develop their innovation	
External	Lack of infrastructure for technology	LR.B12, LR.B40
External	Large heterogeneity within clients' IT ecosystems	
	Market & Economy Barriers	
Internal	Recycled materials must be competitive with virgin alternatives	LR.B15, LR.B25
Internal	Weak negotiation position as start-up	LR.B35
Internal	Innovation's price point often too high for visionary, smaller companies	
External	Brands opt for in-house solutions	
External	Extremely difficult to secure a meeting/get in contact with the right person within brands	
External	Brands/consumers not willing to pay more for circular solutions	LR.B25
External	Hesitant, wait-and-see attitude amongst industry players	
External	Unfair competition by fast fashion brands	LR.B20
External	Insecurity about trajectory of the market blocks investments/collaborations	LR.B21
External	Limited orders prohibit scaling up	LR.B19
External	Gap between production and life of product makes it challenging to sell circular solution to brand	
External	Circular business model not mature in the fashion industry	LR.B31
External	Seasonality of fashion industry limits collaboration opportunities throughout the year	LR.B17
External	Circularity not a priority amongst brands	LR.B22
	Operational & Organisational Barriers (I)	
Internal	Timing of industrialisation is challenging	
Internal	Challenging to capture enough feedstock/waste	
Internal	Challenging to obtain sufficient human capital to scale up	LR.B33
Internal	Founding/managing start-up extremely stressful	LR.B33
Internal	Misalignment between founding members/start-up teams	LR.B33
Internal	Scaling of production capacity blocked by lack of suitable location/plant	LR.B41
Internal	Limited (scaling of) production capacity due to limited equipment/spare parts	
Internal	Challenging to balance R&D with other activities	LR.B16
Internal	Challenging to set up industrial plant close to feedstock producers	
Internal	Attending start-up competitions time-consuming and costly	
Internal	Challenging to retain employees	
Internal	Difficulty attracting skilled employees	LR.B51
Internal	Internal processes of start-up non-existent, challenging to construct them all	
Internal	Sorting textile waste challenging and time consuming	
External	Fluctuating streams of waste from fashion industry	LR.B43
External	Involving/convincing all teams within brand	
External	Long decision-making processes within industry players	
External	Production minima from suppliers	LR.B42
External	Brands prefer ordering large amounts	
External	Brands ordering all at the same time, start-up not able to produce sufficient volume	LR.B43
External	Limited network effects for circular solutions/start-ups	LR.B49
External	Lack of care & repair workshops	

Context	Barrier	Match LR
	Operational & Organisational Barriers (II)	
External	Lack of suitable plants/manufacturers in France	LR.B36, LR.B41
External	Heterogeneity of textile deadstock/waste	
External	Heterogeneity in client workflows	
External	IP protected materials can make recycling/reusing amongst luxury brands challenging	
External	Implementing circular solution within brand slow, step-by-step process	LR.B2, LR.B38
External	Brands don't switch suppliers/manufacturers easily	
External	Suppliers/manufacturers not unwilling to work with/test new technology or material	LR.B38
	Social & Societal Barriers	
Internal	Lack of connections in fashion industry makes it challenging to get into	LR.B1
External	Consumers unaware of repair/care options and rights	LR.B3
External	Consumers don't sufficiently value/are unaware of circularity	LR.B3
External	Unfortunate perception of fibre/material in fashion industry	LR.B7
External	Consumers visit physical stores less, while care/repair solutions often require physical touchpoints	
External	Negative/inaccurate perception towards recycling	LR.B7
External	Disrepancy between customer intent and action	
	Financial Barriers	
Internal	Challenging to build profitable/competitive cost proposition	LR.B25
Internal	Innovation not profitable on small scale	LR.B29
Internal	Bridging gap seed and sequential investment round is challenging	
Internal	Challenging to navigate between different funding entities	
Internal	Lack of financial resources	LR.B32
Internal	Underinvesting/slowing down R&D due to lack of resources	LR.B27
Internal	Fundraising without a product/demonstrator is challenging	
Internal	Switch from public to private investment is challenging	
Internal	Need to show IP is properly protected to be attractive to investors	
External	Return on Investment is different for circular solutions, not well recognised in industry/amongst investors	LR.B24
External	Investor insufficient knowledge on industrial KPIs	
External	Unwillingness to adopt solution due to recent investment in alternative technology	
External	(Public) funding projects/call process long and complex	
External	Funding application is one-shot	
External	Lack of funds with textile focus	
External	Public funds often require equal contribution from start-up	
	Regulatory & Policy Barriers	
Internal	Challenging to influence policy-making as start-up	
External	Lack of law enforcement	
External	Lack of harmonised laws internationally	LR.B46
External	Application process for eco-label/certification long and resource-consuming	LR.B44
External	Product/material specifications differ between sectors	
	Information & Knowledge Barriers	
Internal	Limited knowledge/experience about fashion industry as start-up	LR.B52
Internal	Challenging to balance applied vs. theoretical R&D	
Internal	LCA/PEF/impact analysis prerequisite, but resource-consuming to do	LR.B18, LR.B47
Internal	Limited resources make inter-startup projects difficult	
Internal	Challenging to quickly understand and adapt to client's environment	
External	Brands unaware of circular costs/implications	
External	Limited transparency on product origin and content	LR.B45
External	Lack of traceability of textile/material flows within brands	LR.B45
External	Limited information for brands wanting to enter in CE	LR.B4
External	Limited access to brands' LCAs, hence difficult for start-ups to design impactful solution	LR.B37, LR.B53

B.3. TIS Functions

Table B.5: The identified processes and interactions within the seven TIS functions, presented in their coding hierarchy

	Activities and Interactions within the TIS Functions
Entrepr. Experim.	Managing start-up; building & recruiting team; Constructing internal processes; Conducting LCA/PEF/environmental impact study; Identifying customer needs and painpoints; Conducting market studies; Joining accelerator/incubator; Obtaining feedback from environment; Performing iterative product development; Scaling up technology; Regulating quality of process/end product; Designing/improving innovation for market application; Testing value propositions with brands or partners
Influence on Direction of Search	Following other brands in entering CE; Responding to demand for circular products/services; Innovating as preferred solutions are non-existent; Innovating for digital transformation; Recognising urgency of action against climate change; Entering in the CE due to social pressure/reputational risk; Entering in the CE following regulations
Knowledge Developm. & Diffusion	Acting as knowledge broker; Studying brands' circularity/recyclability/LCAs; Co-developing solution; Collaborating with universities/research centres; Developing database; Eco-conceiving products; Educating brands on circular solutions/strategies; Learning from industry consortia/ecosystem associations; Learning from industrial partners; Learning from feedstock suppliers/manufacturers/spinners/weavers; Regulating IP; Participating in collaborative research
Market Formation	Assessing and contacting potential customers; Conducting (explorative) project with brand; Convincing brands/consumers to adopt circular solution; Creating awareness for solution; Creating ecosystem of logistics; Engaging with industry consortia/ecosystem associations; Implementing solutions within brands; Networking; Engaging with region; Securing textile waste/feedstock streams
Legitimation	Building demonstrator/prototype; Constructing proof of value; Applying for/obtaining industry-wide certifications, eco-labels or acknowledgements; Running tests/pilot projects; Participating in competitions; Proving scalability of innovation; Using industry reports to validate innovation
Resource Mobilisation	Obtaining/applying for public funding; Obtaining funding from ecosystem associations or knowledge networks; Obtaining private funding; Obtaining equipment/parts; Securing plant/lab; Securing revenue from customers
Positive Externalities	Enhancing customer engagement; Demanding LCAs/transparency in brand collaborations; Validating business models; Increasing CE know-how within sector; Informing policy-making; Supporting/collaborating with other circular start-ups; Reaching synergies with other actors

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What to take home from this research

If you are a consumer

The overconsumption within Western culture allows brands and manufacturers to capitalise immensely off of micro trends and fashion fads. In Europe, we purchase an average of 26 kgs of textile per year, while this is around 5 kgs in Africa (European Environment Agency, 2019). As this research shows, the adoption of circular solutions, and the transition to a circular fashion system as a whole, is a team effort. Even if brands were to adopt circular solutions overnight, the efficacy of circular ecosystems is dependent on us consumers. Resource loops will not be narrowed, slowed or closed if we do not **adjust our behaviour:** the most sustainable garment is the garment not bought. Rethink whether you acually need a new garment, opt for renting a suit or dress for special occasions (trust me, you will be the best dressed on the night for a fifth of the price), prioritse second-hand, care for your garments throughout their lifetime, purchase from sustainable brands if you are able, and if you dispose of clothing and shoes, do so responsibly.

If you are a brand

Your brand will not become circular overnight. Maybe not even within the next 5 years – however, to contribute to the transition to a more circular and sustainable fashion industry, it is vital to support innovation within the fashion industry. **Actively pursue interactions with circular-born start-ups** or other innovative entities that could benefit off of the experience, know-how and financial or organisational resources from your brand. Allocate someone within the firm that manages the relationship with start-ups. Circular solutions require input from each department within a firm, but it shouldn't be up to the start-up to navigate a complex environment they are not familiar with. Brand collaborations are the route to market for many circular-born start-ups: you can drive action within the supply chain where start-ups can't, you provide legitimacy to new technologies, and visibility towards other industry stakeholders. It is a unique position to be in, and who knows what types of competitive advantages might be up for grabs when giving new circular technologies a chance.

CIRCULAR IS THE NEW BLACK