

# **Increasing the use of recycled textiles through business models and policies**

A study providing practical insights based on industry front-runners

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## **Abstract**

The current textile industry is among the most polluting industries and actions should be taken to decrease these negative impacts. One issue that should be addressed is the increasing amount of textile waste. Post-consumer textiles are often incinerated or downcycled due to many factors. In order to move towards a circular clothing system, businesses and policy makers play a major role. The purpose of this research is two-fold: identifying how business models can be adjusted to increase textile recycling; and exploring which policies have the potential to increase recycling. The exploratory variable-based approach provides researcher with real-world insights and an understanding of the textile recycling market. Business model adjustments are proposed using the Circular Business Model Canvas framework developed by Lewandowski (2016). Additionally, a policy package is proposed consisting of Mandatory EPR, consumer information and customer convenience.

**Keywords:** Post-consumer textile recycling, circular clothing system, (circular) business models, business model innovation, policy instruments, extended producer responsibility, recycled textiles.

## **Executive Summary**

The research is part of the Fibersort Project and written for Circle Economy.

### **Background**

Currently, the production, use and disposal of clothes is extremely resource intensive and creates a tremendous burden on the environment and the people making our clothes. The pressure on the resources increases vastly with a drastic increase in consumption, while simultaneously the times the (lower quality) clothes are utilized decreases each year. As a result enormous amounts of textile waste is generated, that in some cases is barely worn. It has been estimated that less than 3% is currently recycled into new clothes and over 70% is incinerated and landfilled<sup>1</sup>. Many (fashion) brands have an ‘one-directional model of production’ in which new materials are extracted and used as input for production to create products, usually to be thrown away long before the end-of-life. But recycling post-consumer textiles has the potential to significantly reduce the enormous amount of textile waste as well as reduces energy consumption, water consumption, water pollution and lowers the use of virgin materials.

### **Problem definition**

An increasing number of brands sign commitments to move towards a circular fashion system: (i) improving design strategies to enable reuse and recycling, (ii) increasing the number of garments collected at end-of-life, (iii) increasing the volume of garments resold, (iv) and the share of recycled post-consumer textiles<sup>2</sup>. Several brands have started to implement strategies to increase the use of recycled textiles, but brands face many obstacles as it is currently very complicated, because of aspects such as a lack in recycling and sorting technologies available, recycled materials cost more than virgin materials, and in most clothes multiple fibers are used which are difficult or impossible to separate and recycle (Elander & Ljungvist, 2016; Watson et al., 2017). Companies and policy makers play a leading role in overcoming these obstacles and drive textile recycling, however there is a lack of understanding on how exactly. In order to increase textile recycling and move the use of recycled textiles from niche to mainstream, the researcher posed the following questions:

- **RQ1: How can fashion brands increase the use of recycled post-consumer textiles through adjusting their business models?**
- **RQ2: Which policies are needed to increase textile recycling and the use of recycled post-consumer textiles?**

### **Method**

The researcher obtained holistic real-world insights across the industry through in-depth interviews with sixteen different stakeholders: fashion brands, recyclers, collector/sorter and policy advisors. Fashion brands that currently use recycled textiles show commitment to change and can provide insights into their experiences and which challenges are holding them back to increase the share of recycled materials. Therefore, the fashion brands selected for this study all use recycled materials or actively trying to through pilot programs. The key variables/strategies discussed with each stakeholder include: using recycled textiles (excl. recycled polyester from PET bottles), collecting garments, and designing garments that can be recycled.

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<sup>1</sup> Ellen MacArthur Foundation, *A new textiles economy: Redesigning fashion's future* (2017), 20.

<sup>2</sup> Global Fashion Agenda, *Signatories and Targets June 2016 – 2020 Circular Fashion System Commitment* (2018).

## Results

RQ1: While the fashion brands interviewed for this study are among the sustainability front-runners in the industry, only one brand is designing for recyclability, four brands have a take-back system set-up, and four brands use post-consumer recycled textiles. According to the recyclers (in this study), around 95% of the recycled textiles are currently post-industrial, proofing the strong need for a focus on post-consumer textiles and alternative ways to create value. This report outlines the experiences and challenges the brands face when trying to implement each circular strategy, providing insights in which adjustments are viable to be applied to the current business models (Chapter 4).

RQ2: The results of this study show that the identified policy interventions can address all of the prominent challenges that are not related to lack of technologies (Table 4-9, page 65). Mandatory Extended Producer Responsibility is expected to have the largest impact as covers the most barriers (6) and is the only policy (in this study) that incentivizes a change in design, drive collection and the use of recycled textiles. Circular Public Procurement (CPP) addresses the second most challenges, though mostly related to workwear and home textiles and thus not likely to push fashion brands. A Material Exchange Platform may provide the solution to an increase in demand for post-consumer textiles, but seems currently unfeasible. Most stakeholders explained that the lack of consumer awareness and convenience to bring back the clothes is a main reason for the low collection rates.

## Conclusions

RQ1: Understanding the experiences of industry stakeholders a Circular Business Model Canvas is proposed, using Lewandowski's (2016) framework (Figure 1). Fashion brands should shift their focus to: designing an increased portion of their collections in a way that they can be recycled; include at least 20% post-consumer recycled cotton, wool or cashmere in garments such as jeans, sweaters, socks and home goods; while offering an incentive to consumers when they return their clothes. Additionally, brands should provide information to consumers about the importance textile recycling and their role in the system, which according to brands in this study, leads to increased consumer engagement and is linked to their sales increase.

<b>Key partners</b>	<b>Key activities</b>	<b>Value proposition</b>	<b>Customer relationships</b>	<b>Customer segments</b>
<ul style="list-style-type: none"> <li>• Create relationships with yarn suppliers directly</li> <li>• Collaborate with collectors (incl. municipality, retailers and charity)</li> <li>• Partner with research and development organizations</li> </ul>	<ul style="list-style-type: none"> <li>• Focus on creating recyclable garments</li> </ul>	<ul style="list-style-type: none"> <li>• Beautiful long-lasting or recyclable garments</li> <li>• Portion of garments contain <math>\geq 20\%</math> recycled post-consumer textiles in:                             <ul style="list-style-type: none"> <li>▪ jeans, sweaters, socks, home-goods</li> </ul> </li> <li>• Incentive to bring back</li> <li>• Reuse garments for reduced price</li> </ul>	<ul style="list-style-type: none"> <li>• Increased consumer engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Higher-end (conscious)</li> <li>• Lower-end, fast-fashion</li> </ul>
	<b>Key resources</b>		<b>Channels</b>	<b>Take-back management</b>
	<ul style="list-style-type: none"> <li>• Natural and sustainable fibers</li> <li>• Mono-fibers/fabrics</li> <li>• Recycled post-consumer textiles</li> <li>• Biodegradable dyes, buttons etc.</li> </ul>		<ul style="list-style-type: none"> <li>• Reverse logistics</li> <li>• Provide online assistance to care &amp; repair clothes</li> </ul>	<ul style="list-style-type: none"> <li>• In-store, own/all brands</li> <li>• Link take-back to relevant recyclers</li> </ul>
<b>Cost structure</b>		<b>Revenue streams</b>		
<ul style="list-style-type: none"> <li>• Costs of take-back system (if not partnered with collector)</li> <li>• Resale has the opportunity for additional revenue</li> <li>• High value recycling more cost effective than downcycling or incineration</li> </ul>		<ul style="list-style-type: none"> <li>• No direct revenue stream has been identified yet</li> <li>• Resale has the opportunity for additional revenue</li> </ul>		
<b>Adoption factors</b>				
<ul style="list-style-type: none"> <li>• Train designers for developing recyclable clothes</li> <li>• Educate consumers on reuse and recycle</li> </ul>		<ul style="list-style-type: none"> <li>• Drive R&amp;D</li> <li>• Prepare for future regulations</li> </ul>		

Figure 1. CBMC developed in this research to increase recycled textiles (copied)

Source: Own work, adopted from 'Designing the Business Models for Circular Economy – Towards the conceptual Framework' (Lewandowski, 2015)

RQ2: This research recommends the European Commission and governments in NWE to implement policy package I consisting of: Mandatory EPR, improving customer convenience regarding collection points and consumer information on reuse and recycling (section 5.3). Mandatory EPR should incentivize brands that: design for recyclability, collect their clothes, extend the product-life and the of use post-consumer recycled textiles (section 4.3.1). Enhanced consumer awareness and convenience are expected to be vital to increase collection rates and a successful EPR scheme. The lack of technology plays a major role in increasing textile recycling, but crucial innovations to enable large-scale textile recycling are expected to arise within five years. Since policies take time to be approved and implemented, governments should start developing policy packages to increase textile recycling now, to speed-up the transition towards a circular clothing system once these innovations are commercialized.

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## **Abbreviations**

BMC	Business Model Canvas
CBM	Circular business model
CMBC	Circular Business Model Canvas
CPP	Circular Public Procurement
EPR	Extended Producer Responsibility
GPP	Green Public Procurement
MOQ	Minimum order requirement
PET	Polyethylene terephthalate
PRO	Producer responsibility organization

# 1 Introduction

## 1.1 Background

The textiles industry is among the most polluting industries, uses vast amounts of resources, and has a negative environmental impact during production, the use-phase, and at end-of-life (Ellen MacArthur Foundation, 2017; Fontell & Heikkila, 2017; Moorhouse & Moorhouse, 2017). The production of fabrics is extremely resource intensive, for instance cotton is a water-intensive crop for which a cotton t-shirt requires on average 2,700 litres of water (Chapagain, Hoekstra, Savenije, & Gautam, 2006). This is alarming since at least 25% of the textile production consists of cotton and the crop is often grown in areas that already face water scarcity (Chapagain et al., 2006; Sandin & Peters, 2018). Additionally, the intensive use of pesticides causes pollution which has negative effects on farmers (Chapagain et al., 2006; Sandin & Peters, 2018) and takes up arable land for food production in developing countries (Roos, Sandin, Zamani, Peters, & Svanström, 2017). The demand for synthetic fibres (e.g. polyester, nylon, elastane) has grown rapidly and resulted in GHG emissions to exceed the transport industry in 2015 (Ellen MacArthur Foundation, 2017). The dyeing and treatment of textiles releases chemicals in waste water and, depending on the treatment, harms ecosystems (Allwood et al., 2006), workers in contact with these chemicals, and people drinking the waste water effluent because it ends up in local water sheds (Kant, 2012). And this all while the production of new clothes often consist of over 97% of virgin materials, including synthetics (63%), cotton (26%) and other (11%) (Ellen MacArthur Foundation, 2017).

These new clothes are only worn for a short period of time (Allwood et al., 2006; Birtwistle & Moore, 2007; Kant Hvass, 2014). Fast-fashion has lowered the intrinsic value of clothes and encouraging consumers to replace and throw-away their clothes before they reached their end-of-life (Birtwistle & Moore, 2007). As a result, nearly 60% of the fast-fashion items are discarded within a year of production (McKinsey, 2016). The average active life of garments in varies from 5 years in Denmark; to 4.1 years in the Netherlands; 3.8 years in Germany and Italy; and 3.3 years in the UK (WRAP, 2017a). The production of textiles has doubled in volume during the last 15 years, yet the times a piece of clothing is worn before discarded has declined by more than one-third (36%) in the past 15 years (Ellen MacArthur Foundation, 2017), as shown in Figure 1-1. The increase in production is primarily due to the rise of 'fast fashion' with shorter production times, allowing clothing brands to introduce new lines all year long (Allwood et al., 2006; Fletcher, 2012; Hawley, 2009). For instance, Zara introduces 24 new collections every year, and H&M between 12 and 16 but updates them every week (Remy, Speelman, & Swartz, 2016). At the same time, the costs of garments have decreased drastically, which has resulted in sales growth (Fletcher, 2012; Hawley, 2009).

Washing and drying clothes requires the largest amount of energy assuming 25 washes (Allwood et al., 2006). Due to the rise of synthetic fibres, washing clothes now releases microfibers (tiny plastic particles) which we cannot separate from the water and thus end up in the ocean (Roos et al., 2017).

The increase in production and consumption of garments, in combination with lower quality materials and lower utilization periods, has resulted in an immense amount of textile waste (Birtwistle & Moore, 2007). The post-consumer textile waste problem is not new but has gained increased attention because growing resource scarcity's, increased use of synthetic fibres, and the vast increase in textile waste of which most (73%) is incinerated or landfilled (Birtwistle & Moore, 2007; Ellen MacArthur Foundation, 2017; Fletcher, 2014; Hawley, 2009). To get a grasp of the magnitude these numbers, this equals a garbage truck of textiles being

landfilled or incinerated every second, which adds up to a total lost opportunity of over USD 100 billion every year (Ellen MacArthur Foundation, 2017). The reason that most garments

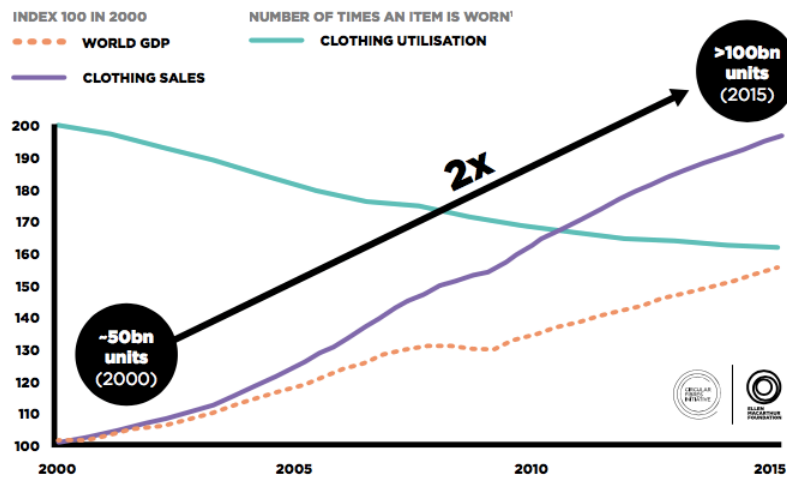


Figure 1-1. ‘Growth of clothing sales and decline in clothing utilization since 2000’  
 Source: Euromonitor International Apparel & Footwear 2016 Edition (volume sales trends 2005–2015); World Bank, World development indicators – GD (2017), retrieved from (Ellen MacArthur Foundation, 2017)

are incinerated or landfilled is because the textile industry currently operates in a ‘linear economy’ (Birtwistle & Moore, 2007) where most fashion brands have an “one-directional model of production”, in which new materials are used as input for production to make products that are usually thrown away after being used only a few times (Esposito, Tse, & Soufani, 2018b). While clothes that are thrown away could be of high value if reused or recycled into new clothes (Allwood et al., 2006; Birtwistle & Moore, 2007; Ellen MacArthur Foundation, 2017; Hawley, 2009; WRAP, 2017). Currently, less than 3% of the textile waste is recycled into fibres that are used in the production of new clothes (Ellen MacArthur Foundation, 2017; Hawley, 2009; MADE-BY, 2018). Downcycling however is more common (an estimated 12%), where textile waste is recycled into materials of inferior quality, for example used as mattress stuffing, insulation material and wiping clothes (Sandin & Peters, 2018). Once these lower-value products reach their end-of-life it is hard to recapture the materials and as a result they often have to be landfilled or incinerated (Ellen MacArthur Foundation, 2017).

## 1.2 Actors in Post-consumer Textile Market

The textile recycling industry is among the oldest and most established recycling industries (Birtwistle & Moore, 2007; Hawley, 2009; Sandin & Peters, 2018), while the infrastructure for high-value reuse and recycling is underdeveloped (Allwood et al., 2006). Multiple stakeholders are operating in the European post-consumer textile market and operate on national and European level (Palm et al., 2014), Figure 1-2 shows a schematic overview. Since only 3% is high-value recycled to be used into new clothes, so what happens to the remaining textile waste?



Figure 1-2. ‘Schematic overview of actors in European market for post-consumer textiles’  
 Source: Own Work. Information obtained from: (Palm et al., 2014)

### **1.2.1 Collector**

Once consumers are done with wearing their clothes they can choose to discard, donate or sell the textile product (Palm et al., 2014). Textiles are then collected by charities mainly, but also by retailers, municipalities and collecting organizations (Palm et al., 2014). The fate of the garment does not seem to differ much from the collection point the consumer chooses. In many cases, collection points of charities, municipalities and retailers are following the same channels, with an exception to fashion brands collecting their own brand and process these themselves (elaborated in the next section). A large portion (70%) of the discarded textiles end up in household waste and as a result are incinerated (10%) or landfilled (60%) (Domina & Koch, 1999; Hawley, 2009; Sandin & Peters, 2018). Around 15-20% of the total discarded textiles are collected (Allwood et al., 2006; Sandin & Peters, 2018). In Sweden, it is estimated that 14 kg of clothing produced domestically per capita per year, of which 11 kg per capita is discarded (Englund, Wedin, Ribul, de la Motte, & Östlund, 2017). Analysis of household waste shows that 7.6 kg of textile waste ends up in garbage, and 3 kg are collected by charity (Englund et al., 2017). The Netherlands communicated similar numbers to the Swedish ones. From the 15 kg of textile waste generated per capita per year, 10 kg is discarded in household waste, and 4-5 kg is collected, of which 50% is reused (Englund et al., 2017).

### **1.2.2 Sorter**

Before the collected garments can be reused or recycled, all textiles have to be sorted. Currently garments are mostly sorted manually resulting in high labour costs of highly skilled workers with low profit margins (Allwood et al., 2006; WRAP, 2014). The clothes are divided in wearables and non-wearables, since the resale of wearables is the primary or only income of the collectors (Hawley, 2009). Different sorting technologies to automate sorting are being developed, but most technologies are not reliable, accurate or only recognize limited types of fibers and blends (Allwood et al., 2006; Englund et al., 2017; WRAP, 2014). As a result, most of the sorted textiles end up being down-cycled, incinerated or landfilled, instead of recovered as high-value material (Ellen MacArthur Foundation, 2017; Palm et al., 2014).

### **1.2.3 Reuse market**

In terms of environmental impact, reusing garments is preferred over recycling (European Commission, 2008a; Sandin & Peters, 2018). The wearables are so called to be reused, a small part is suitable for local second-hand shops, the rest of the items (often of lower quality) are sold and exported to Eastern-Europe, Africa and Asia (Domina & Koch, 1999; Hawley, 2009; Sandin & Peters, 2018; Watson et al., 2016). Afraid of losing their domestic textile manufacturing different countries around the world have posed bans to second-hand imports in the 1980s already, but only temporarily (Haggblade, 1990). In 2019 the imports of second-hand clothes will be banned by governments of the East African Community (Kenya, Tanzania, Uganda, Rwanda and Burundi) (Fontell & Heikkila, 2017). In addition to competition, the export of second-hand clothes shifts the textile waste issue from the developed to the developing countries (Fontell & Heikkila, 2017).

Since garments are often disposed long before the end-of-life, there is a great potential to increase reusing the garments (Roos et al., 2017; Woolridge et al., 2006).

### **1.2.4 Recycling market**

Half of the collected garments are sorted as non-wearables, mostly to be downcycled (Sandin & Peters, 2018). As mentioned before small fraction (3%) of the textile waste is turned into recycled fibres to be used in the production of new clothes (Ellen MacArthur Foundation, 2017). This is because high-value textile recycling is difficult, complicated and some technologies are not economically viable (yet) (GreenBlue, 2017; Sandin & Peters, 2018).

Fashion brands have been absent from the textile recycling industry for a long time, and only recently some fashion brands are engaging to reuse and recycle textiles (Kant Hvass, 2014). For years, the CSR agenda has mostly focused on environmental and social impacts in the supply chain (Birtwistle & Moore, 2007; Kant Hvass, 2014). With the rise of fast-fashion, the textile waste problem has become more apparent and (fast-)fashion brands are increasingly committed to increase the use of recycled materials in the production of new clothes, see Table 1-1.

Table 1-1. Commitments to use recycled materials by fast-fashion brands

Company name	Commitments to use recycled materials
<b>Inditex</b>	“By 2020 we will invest USD 3.5 million in textile recycling technologies, with the goal of upscaling post-consumer mechanical fiber recycling.” (Global Fashion Agenda, 2018b)
<b>H&amp;M</b>	“Only use recycled or sustainably sourced materials by 2030 latest.” (H&M, 2018)
<b>Nike</b>	“[...] We’ve identified two areas for focus: decreasing waste and increasing our use of recycled materials.” (Nike, 2017)
<b>Adidas</b>	“Use only recycled plastics by 2024” (Financial Times, 2018)
<b>Asos</b>	“Each year we will publish external targets for increasing post-consumer recycled textile materials in our products whilst eradicating those that cannot be recycled.” (Global Fashion Agenda, 2018b)
<b>Filippa K</b>	“By 2030 Filippa K’s entire collection will be designed and produced following the principles of circular economy – reduce, repair, reuse and recycle.” (Watson et al., 2017)

But as the low high-value recycling rate indicates: recycling post-consumer garments into fibres to be used in the production of the new collection is challenging for many reasons (Fontell & Heikkila, 2017; Palm et al., 2014; Sandin & Peters, 2018; Watson et al., 2017). The barriers to post-consumer textile recycling will be discussed in the literature review (section 2.6).

### 1.3 Fibersort project

The Fibersort project aims to overcome some of the challenges to post-consumer textile recycling<sup>3</sup>. This research is part of the Fibersort project, where the results may be used for the Fibersort project deliverables. Therefore, the purpose of this section is to provide context to the reader by introducing the technology and the project.

The Fibersort technology sorts textiles based on fiber composition fast and accurately (Circle Economy, 2017; Ellen MacArthur Foundation, 2017). Textile products are manually placed on the conveyor-belt, one by one. Fibersort scans garments through a Near Infrared (NIR) spectroscopic technology, see Figure 1-3. The technology can scan and sort garments made from: “cotton, wool, viscose, polyester, acrylic, nylon, and certain blends of these fibers as well as sorting by color at the same time” (Ellen MacArthur Foundation, 2017). The image

<sup>3</sup> Interreg NWE, *The Fibersort Project Work Packages* (2018). <<http://www.nweurope.eu/projects/project-search/bringing-the-fibersort-technology-to-the-market/#tab-4>>

that is captured during the scan is analyzed and compared to the extensive database of materials and the fiber type is quickly determined (Circle Economy, 2017; Ellen MacArthur Foundation, 2017). The system can process one piece of clothing per second and there is no limit in types of fiber that can be recognized. The system still faces challenges when garments consist of complex blends of three or more materials (Circle Economy, 2017).



Figure 1-3. Images of the Fibersort Technology

Once the non-wearable post-consumers textiles are sorted, the materials turn into reliable, consistent input for textile-to-textile recyclers, see Figure 1-4 (Interreg NWE, 2018). Low value textiles can be recycled into new, high value textiles through existing and arising recycling technologies. The technology potentially creates a tipping point towards a circular textile industry, as it enables large quantities of quality-assured supply to textile-to-textile recyclers at lower costs (Interreg NWE, 2018). When commercialized, it is expected that the Fibersort technology will provide a new market for low-value textiles and generates reliable, consistent and quality assured textile material supply (Interreg NWE, 2017).



Figure 1-4. The Fibersort enables a new, circular textile industry  
Source: Fibersort Project Overview (Interreg NWE, 2018)



Since Fibersort is expected to be a key enabler towards a circular fashion industry, the innovation received funding from Interreg North-West Europe (NWE) to help commercializing the technology and increase the uptake of recycled textiles, referred to as the Fibersort project (Interreg NWE, 2018). Interreg NWE is a European Territorial Cooperation Program funded by the European Commission aiming to improve the NWE region in terms of economic, environmental, social and territorial development (Interreg NWE, 2018b). Interreg NWE funds 60% of projects supporting three thematic priorities in the area: Innovation; Low carbon; and Resource and materials efficiency. The latter is the thematic priority behind the Fibersort project (Interreg NWE, 2018b). The project leader is Circle Economy, a social enterprise based in Amsterdam, and project partners consist of: Salvation Army, ReShare, Procotex, Smart Fibersorting, Wieland Textiles, Valvan Baling Systems, and Worn Again (Circle Economy, 2018). The Fibersort project runs from 2016 – 2019 in the project area consisting of the UK, the Netherlands and Belgium (Interreg NWE, 2018). The main goal of the Fibersort project is to close the loop on textiles. In order to do so, industry input and collaboration is very important for the success of this project (Circle Economy, 2018). Therefore Circle Economy tries to create a network of frontrunning organisations to collaborate and increase circularity in the fashion industry. The stakeholders involved are: textile collectors and sorters; chemical and mechanical recyclers; apparel brands and designers; retailers; and manufacturers.

## **1.4 Problem definition**

With the speed that consumers now go through their clothes and the small percentage that is being recycled, the current linear system is wasteful and puts extreme pressure on numerous resources (Allwood et al., 2006; Chapagain et al., 2006; Ellen MacArthur Foundation, 2017; Hawley, 2009). Extending the utilization periods of the garments is crucial in reducing the environmental impacts and waste of the textile industry (Sandin & Peters, 2018; Watson et al., 2017). However, whether the active lifetime of textile products are short or long, all textiles have to be handled as waste at some point (Birtwistle & Moore, 2007; Watson et al., 2017). Recycling has the potential to turn waste into resources, replace the dependency of non-renewable resources, and reduce environmental impacts (Ellen MacArthur Foundation, 2017; Sandin & Peters, 2018). More and more fashion brands are announcing targets to include recycled content into their garments (Table 1-1) (Global Fashion Agenda, 2018; Waston et al., 2017). Businesses and policymakers play a leading role in driving textile recycling and create a demand for recycled textiles (Allwood et al., 2006; Ellen MacArthur Foundation, 2017; GreenBlue, 2017; Kant Hvass, 2014; Watson et al., 2017). However, recycling post-consumer textiles into new fibres is challenging for various reasons (see literature review), and as a result, fashion brands face several challenges to increase the portion of recycled textiles into their new productions (Ellen MacArthur Foundation, 2017; Watson et al., 2017).

Several researches have studied various important aspects of increasing the use of recycled textiles such as:

- the current situation of the textile recycling industry (Allwood et al., 2006; Hawley, 2009; Tham, 2008; Watson et al., 2017);
- the fashion brands' drivers and challenges to use recycled textiles (Kant Hvass, 2014; Watson et al., 2017);
- identifying and analyzing innovative and emerging business models related to textile reuse and recycling (Guldmann, 2016; Kant Hvass, 2014; Pal & Gander, 2018; Todeschini et al., 2017);
- consumer behavior and their role increase textile recycling (Allwood et al., 2006; Birtwistle & Moore, 2007; Domina & Koch, 1999; Fontell & Heikkila, 2017);

- models of what a circular clothing system or ecosystem could look like (Fontell & Heikkila, 2017; Tham, 2008);
- identifying policies that have the potential to increase post-consumer textile recycling (Dahlbo, Aalto, Eskelinen, & Salmenperä, 2017; Elander et al., 2017);
- impact assessment on a few selected policies (Dahlbo, 2017; Elander et al., 2017).

Challenges and opportunities experienced by Nordic fashion brands have been studied by different researchers, such as: (Elander & Ljungkvist, 2016; Kant Hvass, 2014; Watson et al., 2017). This research aims to add to literature by confirming or adding to these opportunities and challenges from fashion brands of a larger geographical scope, and additionally interview recyclers, collectors/sorters, and policy advisors, to get a more holistic view of the post-consumer recycling market.

Table 1-2. Research available on policy assessment of different instruments to increase textile recycling

Literature Source	Description	Voluntary EPR	Mandatory EPR	Green Public Procurement	Requirements convenience	Bonus malus system	Refunded Virgin Payments	Consumer information	Eco-labels	Labeling requirements	Material exchange platform	Invest grants in technologies
(Elander et al., 2017)	Evaluates the shortlist of 10 policies on: obstacles addressed, critical factors in design, risk factors, conflicts and synergies, and stakeholders affected. Additionally analyzes in-depth EPR and RVP (marked in light-grey)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
(Dahlbo et al., 2017)	Evaluation of three policy instruments on: impacts, effectiveness, cost effects and acceptability	✓		✓								✓
(Bukhari et al., 2018)	Analysis of EPR policy in France		✓									
(Tojo et al., 2012)	Discuss relevant issues for EPR implementation (such as: collection and crossing borders), up-/downstream achievements, potential and limitations		✓									
(Watson et al., 2014)	Proposal of three packages of policy instruments for EPR and business models, analyzing: critical factors, risks, synergies	✓	✓									

The literature available which studied which and how policy instruments could increase the recycling of post-consumer textiles is limited. Currently, Elander et al. (2017) is the most complete document available (see Table 1-2), identifying different policies that increase post-consumer textile recycling, gained stakeholder input (e.g. brands, recyclers, collectors) on those policies, and a policy assessment of two selected policies. However, there are a few studies available that looked at one or a few policies related to textiles, see Table 1-2 on the previous page.

While circularity and using recycled materials are increasingly becoming part of brands strategies, the use of recycled materials is still relatively niche (Watson et al., 2017). In order to increase textile recycling and move the use of recycled textiles from niche to mainstream, this research looks at which business models and/or strategies frontrunning brands (in terms of textile recycling) implemented to increase the use of recycled and which challenges and opportunities they experienced. Then use these results to pinpoint where policy should step in and explore which policy instruments are suitable to increase the use of post-consumer recycled textiles.

## 1.5 Research questions

Building on the problem definition, the following two research questions are posed:

**RQ1: How can fashion brands increase the use of recycled post-consumer textiles through adjusting their business models?**

This research question will be answered by first studying the business model concept and business model innovation. Followed by studying how frontrunning fashion brands are currently increasing the use of recycled textiles through adjusting their business models and exploring the brands' experiences and challenges during the implementation of recycled textiles. Additionally relevant experiences and challenges of the other stakeholders are explored.

**RQ2: Which policies are needed to increase textile recycling and the use of recycled post-consumer textiles?**

The answer of the second research question will be obtained through: analyzing the obstacles stakeholders experience to increase the use of recycled textiles, find which policies have the potential to increase post-consumer textile recycling and discuss the key considerations in the design of the recommended policies.

## 1.6 Scope

This research explores which and how circular strategies can be applied to increase the uptake of recycled textiles by brands. Exploring through the case-based approach which business model components are currently possible and how they could be applied to increase textile recycling. The selected stakeholders consist of eleven fashion brands that actively tried to use of recycled materials in the production of new clothes either through implementation or conducting pilots. In addition, in order to gain a holistic view on the current situation of the textile recycling market recyclers, experts, a collector and sorter, and policymakers are interviewed. This research does not explore fashion brands that do not use any recycled materials

While the author acknowledges that the reuse of the garments is the first preferred option, because it requires lesser resources than recycling (usually solely cleaning and mending), this research focuses on textile recycling. The focus is in particular on high-value recycling, where

the output of recycled clothes could be fed into the production of new garments. Thus, recycled polyester made from PET bottles is out of the scope of this research. While it is great that plastics bottles are recycled and used as new materials in garments, it (i) also makes the polyester blends more difficult to recycle again, (ii) produces microplastics, and (iii) does not address textile waste (Ellen MacArthur Foundation, 2017).

Since the project area of Fibersort is in NWE, this research has its main focus on this region. However, a few relevant companies outside the NWE area were also selected which did use recycled textiles with the aim to increase the sample size, increasing the reliability of results. Policies however, are only focused within the scope of the region, thus the Waste Directive and REACH are not explained.

Only policies that increase textile recycling or increase the use of recycled textiles by fashion brands are within the scope of this research. In this report, the author will not assess the policies and their impacts in depth, but rather give an overview of existing policies that are key in driving the uptake of recycled textiles and why.

## **1.7 Limitations**

One of the limitations of this research is that the selected brands only represent the industry frontrunners, and may not represent the challenges and possibilities other companies have. Besides, a relatively small sample size was studied (16 stakeholders), in case a higher reliability of the results is required, additional stakeholders should be added to this study. The interviews were mostly conducted with one person per company, this may result in incomplete information. Crucial information was verified through ensuring CSR reports and company websites were aligned. Most of the stakeholders interviewed are part of the Fibersort project.

The lack of research available on policy instruments that could stimulate textile recycling has posed limitations for this research. While the report written by Elander et al. (2017) has offered great insights and information, this information cannot be verified with other sources. Besides, only a few stakeholders were familiar with policies, increasing the dependency on Elander et al. (2017).

The author sought to provide adjustments to the regular business models of fashion brands in a way that can be transferable using the BMC framework. However, it is uncertain to what extent the proposed CBMC really is transferable for fashion brands, especially the ones that do not have sustainability at the core of their business. Also, practices that are proved to be feasible by front-running fashion brands may not be feasible by other fashion brands.

Finally, the scope of this research is quite extensive looking at both business models and policies, and multiple stakeholders in the industry (i.e. fashion brands, recyclers, collectors and sorters, and policymakers). As a result in some cases depth may be lacking. However, this decision was made in order to obtain a holistic understanding of the situation in the textile recycling market.

## **1.8 Audience**

Information in this report may be used in the public report as part of the deliverables of the Fibersort Project, in September 2019. Therefore the audience of this thesis is Circle Economy, Interreg NWE and every party involved in the Fibersort project. Besides, results will be shared with all companies interviewed.

## **1.9 Disposition**

Chapter 1 sets out the context through presenting the background and the problem definition.

Chapter 2 consists of the literature framework examining circular business model innovation and policies that could stimulate textile recycling

Chapter 3 explains the methods used to conduct this research

Chapter 4 describes the findings obtained through literature review and qualitative data collection

Chapter 5 analyzes and discusses the findings resulting in the proposed adjusted business model and policy packages

Chapter 6 presents conclusions drawn from the research

## 2 Literature review

The literature review serves as the foundation of this research, where concepts and terms are explained, and relevant literature is compiled and summarized. First, the textile recycling typologies are described to set the solid basis in the terminology of this report. Then, the concepts around the circular economy and business models are presented. This chapter closes with the relevant policies stimulating textile recycling.

### 2.1 Textile recycling typologies

Textile recycling is at the center of this research, and while the term seems straightforward, it is often confused in brands' communications with textile reuse and remanufacturing. For this reason the concept and will be defined here as well as common terms such as downcycling, upcycling and high-value recycling.

#### 2.1.1 Textile recycling

*Textile recycling* is a process where pre- or post-consumer textile waste is turned into new yarns and fabrics, usually through mechanical or chemical processes (Sandin & Peters, 2018). There are multiple levels in which textile recycling can capture value, see Figure 2-1. In this thesis, textile recycling refers to 'fiber recycling' mostly, but also incorporates chemical recycling if the input is textile waste (see Figure 2-1). Garments that contain recycled polyester where the source is PET bottles instead of textile waste, are not included in the term textile recycling (Sandin & Peters, 2018).

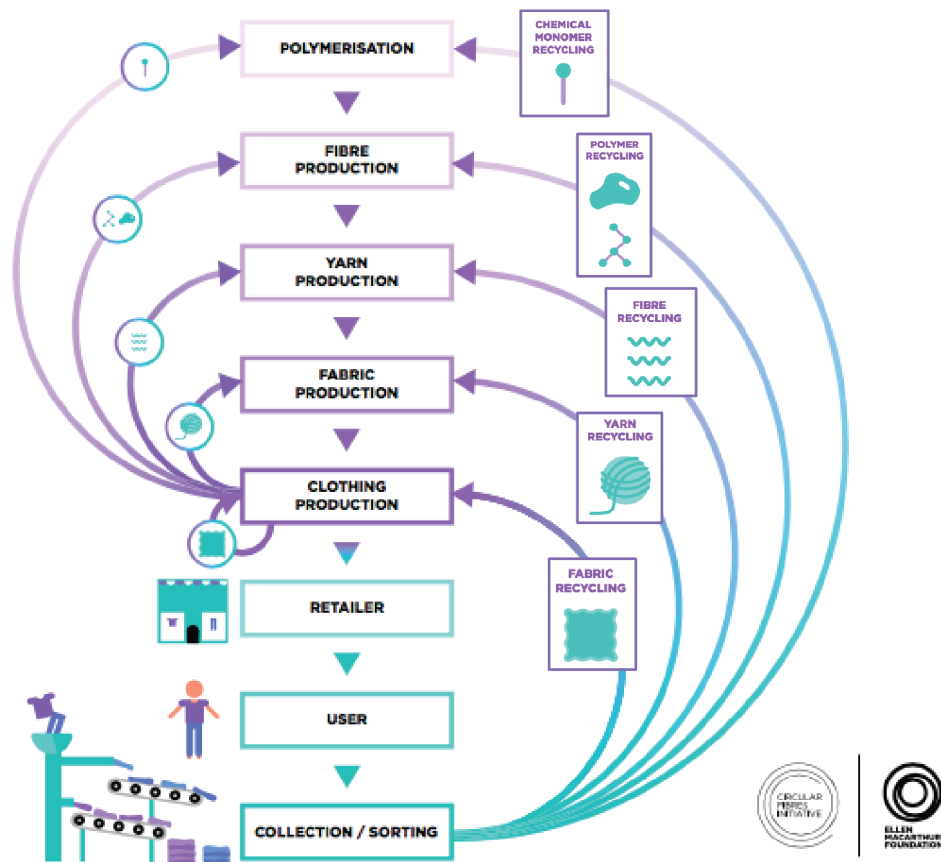


Figure 2-1. 'Textile recycling can capture value at different levels'  
Source: *A new textiles economy : Redesigning fashion's future* (Ellen MacArthur Foundation, 2017).

### **2.1.2 Textile reuse and remanufacturing**

*Textile reuse* refers to extending the life-cycle of textile products by changing owner/user, with or without modifications such as cleaning or mending (Sandin & Peters, 2018). *Textile remanufacturing* is a process where clothes are produced by the use of existing fabrics (factory scraps, deadstocks) (Circle Economy, 2015) also called ‘fabric recycling’ (Ellen MacArthur Foundation, 2017), see Figure 2-1.

### **2.1.3 Mechanical recycling**

*Mechanical textile recycling* usually involves sorting the garments and the removal of non-recyclable objects (buttons, zippers, pockets). The recyclable fabrics are then mainly shredded, but also crushed or pulled mechanically into small fibers, and spun into new yarns (Hawley, 2009). Also referred to as ‘fiber recycling’, see Figure 2-1. The shredding can cause the textile fiber to shorten which lowers its quality and loses its strength, and is therefore often mixed with virgin fibers (in particular with cotton and wool) (Ellen MacArthur Foundation, 2017; Rengel, 2017). Currently, wool and cotton are most often mechanically recycled (Rengel, 2017).

### **2.1.4 Chemical recycling**

*Chemical textile recycling* depolymerizes the fabric to a base-chemical molecule (i.e. monomer) and then, through the addition of chemicals, repolymerised into new virgin quality yarn (Rengel, 2017). This technology can also be used to separate materials (Rengel, 2017). Polyester (95% from plastic bottles) and nylon (mostly from fish nets) are chemically recycled (Ellen MacArthur Foundation, 2017). While promising due to the high-quality output, the chemical recycling technologies “are not yet technologically or economically mature” (Rengel, 2017).

### **2.1.5 Downcycling, upcycling, high-value recycling**

As mentioned before, downcycling refers to recycled materials of lower quality than the original product (Bocken et al., 2016; Sandin & Peters, 2018). *Upcycling* occurs when recycled materials are of higher quality than the original product (Bocken et al., 2016). The term upcycling broadly used, also for instance when fabric scraps and garments are cut into pieces and made into new clothes or products of a higher value (Sandin & Peters, 2018). Therefore, in this thesis, textile-to-textile recycling with ‘high-value’ output that can be used in the production of new yarns is referred to as *high-value recycling* (Circle Economy, 2015).

### **2.1.6 Closed- and open loop recycling**

In closed loop recycling “the loop between post-use and production is closed, resulting in a circular flow of resources” (Bocken et al., 2016), while open loop recycling occurs when materials are recycled and used as an input in another product (Sandin & Peters, 2018). In some cases, closed loop recycling is referred to when recycled materials are used to produce new products within the same industry, and open loop recycling when using recycled materials in new products at another industry. In this thesis, *closed loop recycling* refers to use of recycled resources within the company. While *open loop recycling* refers in this research to using recycled materials from another company, but within the industry. If recycled materials are produced by one industry and used by another it will be clearly stated (e.g. using PET bottle flakes as recycled materials in new garments).

## **2.2 Circular economy**

In our current system, natural (non-renewable) resources are used as factory inputs in order to create products that will generate profits and thrown away at the end-of-life, often after a single use (Esposito et al., 2018). This system is also referred to as a linear economy in which we take-make-use-dispose (Bocken et al., 2016), and creates large amounts of waste from

materials that are made to last forever (Esposito et al., 2018). This one-directional way of production is not sustainable and causes us to use resources faster than the earth can produce, while sending valuable materials to be landfilled or incinerated (Esposito et al., 2018). In response, research for a different production and consumption has increased popularity: the circular economy (Esposito et al., 2018; Geisendorf & Pietrulla, 2018). The circular economy aims to decouple “economic activity from the consumption of finite resources” (Ellen MacArthur Foundation, 2018b) and is seen as the one of the few solutions for a sustainable economy and provides an optimistic long-term outlook by governments, companies and academics (Esposito et al., 2018; Geisendorf & Pietrulla, 2018; Lacy et al., 2014).

Among the most accepted definition comes from the Ellen MacArthur Foundation (De Angelis, 2018; Geisendorf & Pietrulla, 2018): “an industrial system that is restorative or regenerative by intention and design that replaces the end-of life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impairs reuse and aims for the elimination of waste through the superior design of materials, products, systems, and within this, business models” (Ellen MacArthur Foundation, 2013). In order to provide structure, the concept is based on three principles: “(i) design out waste and pollution, (ii) keep products and materials in use, and (iii) regenerate natural systems” (Ellen MacArthur Foundation, 2018). The butterfly model (Figure 2-2) is a visual representation of the production and consumption model consisting of two cycles: (i) in the biological cycle materials can be decomposed by living organisms, (ii) materials in the technical cycle cannot be broken down biologically or cause contamination and are therefore designed to be shared, reused, remanufactured, and ultimately recycled (Ellen MacArthur Foundation, 2013).

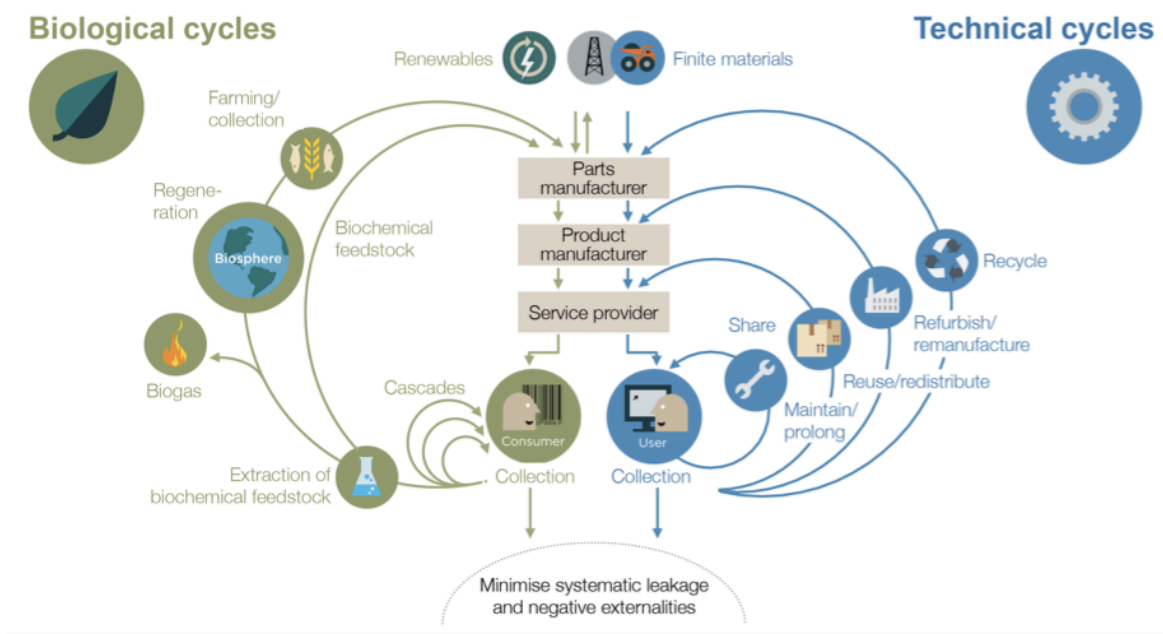


Figure 2-2. The Butterfly model developed by the Ellen MacArthur Foundation & McKinsey  
 Source: *Towards the Circular Economy*, (Ellen MacArthur Foundation, 2013)

The European Union is committed to move towards a circular economy and has set up the EU Action Plan for the Circular Economy in which the term is defined as: “In a circular economy the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimized” (European Commission, 2015). Perhaps the most complete definition may be: “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” (Geissdoerfer, Savaget, Bocken, & Hultink, 2017).

## 2.3 Circular clothing system

Applying the circular economy concept to the textile industry results in a circular clothing system. The circular clothing system moves away from the linear take-make-waste model and collects the garments at the end-of-life to be reused or recycled (Ellen MacArthur Foundation, 2017; WRAP, 2017a)(Ellen MacArthur Foundation, 2017; WRAP, 2017), see Figure 2-3. The image below is similar from WRAP (2017) but two arrows are added: sorting and design.

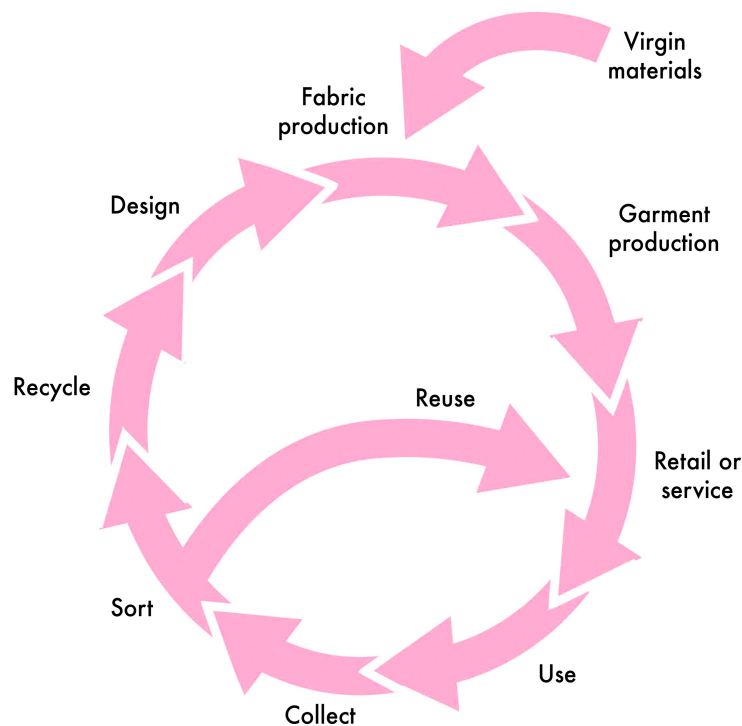


Figure 2-3. The circular clothing system

Source: Own work, adapted from – ‘Mapping clothes in Europe: the environmental cost’ (WRAP, 2017)

Change in design plays a crucial role in moving to a circular economy, with a focus on recyclability, longevity, reparability and the use of recycled textile fibers (Ellen MacArthur Foundation, 2017). In order to be able to recycle the garments at the end-of-life, it is important that the collected items are sorted accurately to send batches containing the same materials to the recycling plants (Ellen MacArthur Foundation, 2017; Watson et al., 2014).

To push the transition to a circular clothing system the Global Fashion Agenda (GFA) set out four “immediate action points” (Global Fashion Agenda, 2018a):

1. Implementing design strategies for cyclability
2. Increasing the volume of used garments and footwear collected
3. Increasing the volume of used garments and footwear resold
4. Increasing the share of garments and footwear made from recycled post-consumer textile fibers

At the Copenhagen Fashion Summit 2017, the GFA tried to increase the number of companies moving towards a circular system through signing the 2020 Circular Fashion System Commitment. Nearly 100 fashion brands and retailers have signed the commitment (representing 12,5% of the global fashion market), where targets are set individually per company regarding one or more of the action points above (Global Fashion Agenda, 2018a).

Since many brands signed the 2020 Circular Fashion System Commitment, it is likely that frontrunning brands now have experiences in implementing one or more action points and have valuable experiences to learn from. The study from Watson et al. (2017) confirms that fashion brands are implementing the action points regarding textile recycling (design, collection and use of recycled textiles) and explores the experiences from Nordic brands.

The experiences when implementing these action points gives us insight into which and how strategies are currently used, what the challenges are, and where to pay attention to when implementing the strategies. Therefore in this study, the GFA action points related to post-consumer textile recycling are discussed with frontrunning fashion brands, namely: (i) design garments that can be recycled; (ii) collect the used garments; and (iii) increase the share of garments made from recycled post-consumer textile fibers. The three action points are explained briefly below.

- **Design for recyclability:** designing clothes in such a way that they can be (easily) recycled at the end-of-life (Bocken et al., 2016; Ellen MacArthur Foundation, 2017). In the case of clothing, this includes the choice of material, dyes and additives such as: zippers, buttons, prints, pockets and glitters (Ellen MacArthur Foundation, 2017; Goldsworthy, 2014). Regarding materials, brands can choose to focus on using natural mono-fibers or mono-fabrics of blends that are recyclable (e.g. cotton, wool, polyester, blends with high cotton percentage), and lower the use of synthetic fibers and number of fibers blended (Elander & Ljungkvist, 2016; Goldsworthy, 2014). Most of the fabrics are dyed with biological dyes and additives are lowered to a minimum or consist of recyclable or biodegradable materials (Ellen MacArthur Foundation, 2018a).
- **Take-back management:** When consumers do not want to use their clothes anymore, brands collect or take-back the clothes. Ideally they are designed in way that they can be high-value recycled and to use the recycled output again in the production of new garments (Ellen MacArthur Foundation, 2017; Fontell & Heikkila, 2017; MADE-BY, 2018). Take-back management can be done through different channels which often consist of: donating to charity, throwing in textile bins in the municipalities, and brands themselves through providing in-store bins, shipping options or through retailers or other organizations (Palm et al., 2014; Sandberg, Pal, & Hemila, 2018).
- **Use of recycled content:** And finally, ‘use of recycled content’ implies (in this study) that companies use high-value recycled textiles made from post-industrial or post-consumer textile waste (not recycled polyester from PET bottles). As mentioned before, textile waste is processed mechanically or chemically into recycled fibers, which are often mixed with virgin fibers to improve the quality (strength, stretch, feel) (Ellen MacArthur Foundation, 2017). While the focus of the research is on post-consumer textiles, post-industrial textiles are also evaluated to get a more holistic view of the use of recycled content. The high-value recycled materials can either be recycled from textile waste of other companies (open loop) or from garments of the own brand of the company (closed loop). Minimizing waste through incorporating recycled materials in new products is at the core of a circular economy.

## 2.4 Business models

This research explores how business models could be adjusted to increase textile recycling, therefore the concept is described below.

There is an overall agreement on the basic definition of a business model: the description of how an organization does business (Richardson, 2008). This description is rather short and explains the rationale behind the actual operations (Richardson, 2008) or the economic model of a business (Morris, Schindehutte, & Allen, 2005). Yet there is no complete consensus on what a business model is exactly (Arend, 2013; De Angelis, 2018; Lewandowski, 2016; Osterwalder, Pigneur, & Tucci, 2005; Zott, Amit, & Massa, 2011). Compiling eighteen different perspectives on business models, Morris et al. (2005) found that the components of business models varied greatly. The most reoccurring components included: value proposition (11 times), revenue or economic model (10), customer relationship (8), partnerships (7), internal infrastructure (6), and target markets (5) (Morris et al., 2005).

In response, Richardson (2008) developed a simplified and logical framework that help companies to link its strategy to its operations. The framework is based on common themes found in literature, resulting in three major components (Richardson, 2008):

- Value proposition - what is offered to consumers, which consumers are targeted, and what is the competitive advantage that makes people want to pay for the product/service?
- Value creation and delivery system – which activities are needed to create, produce, sell, and deliver the product/service to consumers?
- Value capture – what are the costs, how is revenue generated, and is the company viable?

### 2.4.1 Business Model Canvas

One widely recognized definition of a business model is described by Osterwalder and Pigneur (2010): “A business model describes the rationale of how an organization creates, delivers, and captures value” (Lewandowski, 2016; Lüdeke-Freund, 2010; Mentink, 2014). In order to make the concept useful for practioners, the authors developed a framework consisting of nine building blocks and is known as the business model canvas (BMC) (Osterwalder & Pigneur, 2010). The BMC visual presents the dynamics of the components within a business model, see Figure 2-4. Even though Osterwalder & Pigneur (2010) were not part of the study of both Morris et al. (2005) and Richardson (2008), the components of both frameworks are very similar. The ‘value propositions’ is the center of the BMC and states what creates value to the customers. The ‘back stage’, see Figure 2-4, represents the four key elements that enable the operation side of the business model and its costs. The “front stage” manages the interaction with markets and customers and how revenue is generated (Smith-Gillespie, 2016).

The BMC is relevant to this research as it is one of the most (if not the most) used framework applied by business practitioners around the world and has provided common language to discuss and understand business models internationally (Antikainen & Valkokari, 2016; Lewandowski, 2016; Smith-Gillespie, 2016).

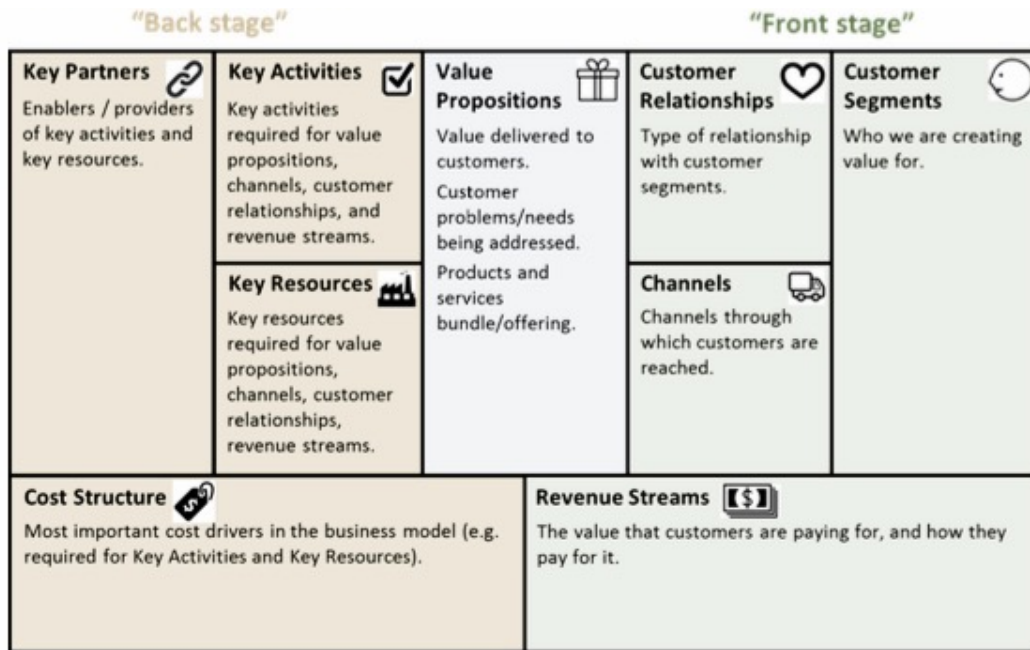


Figure 2-4. The Business Model Canvas  
 Source: Adaptation from Business Model Generation (Osterwalder and Pigneur, 2010)

## 2.5 Circular business models

The importance of developing new business models conform the circular economy principles is often stated, yet it is not certain what they will look like (De Angelis, 2018). There is however a common understanding regarding the change from ownership- to performance based model, where products are designed to last long and reuse (De Angelis, 2018; Esposito et al., 2018; Lacy et al., 2014). Circular business models definitions are compiled in Table 2-1.

Table 2-1. Summary of CBMs definitions

Literature	Definition of a Circular Business Model
Linder and Williander (2015)	“A business model in which the conceptual logic for value creation is based on utilizing the economic value retained in products after use in the production of new offerings”
Bocken et al. (2016)	“Circular business models contribute to the slowing, closing, and narrowing resource loops”
Korhonen et al. (2018)	“A circular business model describes how an organization creates and captures value in a circular economy; it distinguishes itself from traditional (‘linear’) models by its focus on high value and high-quality material cycles”
Smith-Gillespie (2016)	“A circular economy business model is one which creates, delivers, and captures value in a manner that is compatible with and enables regeneration of finite natural resources, and keeps products, components and materials at their highest value and utility within a relevant system boundary”
Mentink (2014)	“The rationale of how an organization creates, delivers and captures value with and within closed material loops”

The fact that circular business models would solely focus on closed-loop systems, as proposed by Mentink (2014), is inadequate (Lüdeke-Freund, Gold, & Bocken, 2018). While Linder and Williander (2017) and Korhonen et al. (2018) have a more complete definition of a circular

economy, the definitions of circular business models place the emphasis on using the process materials at end-of-life in the production of new products. When looking at the principles of the circular economy (i.e. design out waste and pollution, keep products and materials in use, regenerate natural systems), the definitions from Bocken et al. (2016) and Smith-Gillespie (2016) seem to be most complete. Both Bocken et al. (2016) and Smith-Gillespie (2016) focus on extending the utilization period of a product as well as process the products at end-of-life to be used in the production of new materials.

### 2.5.1 Circular Business Model Canvas

The BMC is used as the foundation of circular business model innovation by a range of authors including: (Antikainen & Valkokari, 2016; Lewandowski, 2016; Mentink, 2014; Smith-Gillespie, 2016). Moving towards circular business models requires adjustment and expansion of the BMC, however the framework is popular mainly due to its simplicity and flexibility (Smith-Gillespie, 2016) and is thus an important consideration when studying how business models could be adjusted to increase textile recycling.

Aiming to improve the transferability of circular business models, Lewandowski (2016) developed a conceptual framework of circular business model innovation. Basically, he adapted the nine building blocks from BMC by Osterwalder and Pigneur (2010) but adjusted how these building blocks contribute to the business model in line with circular economy. Additionally, Lewandowski (2016) extended the BMC into the Circular Business Model Canvas (CBMC), by adding two building blocks: Take-back system and Adoption factors, see Figure 2-5.

<b>Partners</b> <ul style="list-style-type: none"> <li>Cooperative networks</li> <li>Types of collaboration</li> </ul>	<b>Activities</b> <ul style="list-style-type: none"> <li>Optimising performance</li> <li>Product Design</li> <li>Lobbying</li> <li>Remanufacturing, recycling</li> <li>Technology exchange</li> </ul>	<b>Value Proposition</b> <ul style="list-style-type: none"> <li>PSS</li> <li>Circular Product</li> <li>Virtual service</li> <li>Incentives for customers in Take-Back System</li> </ul>	<b>Customer Relations</b> <ul style="list-style-type: none"> <li>Produce on order</li> <li>Customer vote (design)</li> <li>Social-marketing strategies and relationships with community partners in Recycling 2.0</li> </ul>	<b>Customer Segments</b> <ul style="list-style-type: none"> <li>Customer types</li> </ul>
	<b>Key Resources</b> <ul style="list-style-type: none"> <li>Better-performing materials</li> <li>Regeneration and restoring of natural capital</li> <li>Virtualization of materials</li> <li>Retrieved Resources (products, components, materials)</li> </ul>		<b>Channels</b> <ul style="list-style-type: none"> <li>Virtualization</li> </ul>	
	<b>Cost Structure</b> <ul style="list-style-type: none"> <li>Evaluation criteria</li> <li>Value of incentives for customers</li> <li>Guidelines to account the costs of material flow</li> </ul>		<b>Take-Back System</b> <ul style="list-style-type: none"> <li>Take-back management</li> <li>Channels</li> <li>Customer relations</li> </ul>	
<b>Adoption Factors</b> <ul style="list-style-type: none"> <li>Organizational capabilities</li> <li>PEST factors</li> </ul>				

Figure 2-5. 'Circular Business Model Canvas'

Source: adapted from Lewandowski (2016)

A similar approach was taken by Antikainen & Valkokari (2016), using the BMC as the foundation of circular business model innovation, but argue the need for multilevel analysis and added two levels (a visual representation is provided in Appendix A). The first level consists of the key trends and drivers (such as innovations and upcoming regulations) and the importance of creating value for a broader range of stakeholders (e.g. not only customers, but also for suppliers, municipalities and recyclers) (Antikainen & Valkokari, 2016). The second addition regards the impact of the business model measuring the 'sustainability costs and

benefits’ such as calculating packaging impacts (costs) as well as resource efficiency and recycling (benefits) (Antikainen & Valkokari, 2016). The framework should continuously be under assessment regarding sustainability and circularity impacts to optimize processes (for instance through life-cycle assessments (LCA’s) and monitoring flows of materials and cycle stages) (Antikainen & Valkokari, 2016). In order to optimize processes and move to a circular business model, collecting and monitoring data can give an insight of the companies achievements and where changes in the business model are beneficial (Antikainen & Valkokari, 2016). Whether fashion brands are able and willing to collect and monitor additional required data is questionable and out of scope of this research. However, when companies take efforts to move to sustainable or circular business practices, the efforts and achievements are often presented in Corporate Social Responsibility (CSR) reports. Adding the information available to the BMC could give a clearer overview for the companies of the achievements but also the negative impacts still need to be addressed. Nevertheless, only presenting a few sustainable costs and benefits in the canvas may give an incomplete picture of the impacts of the business model. Therefore this framework may require extensive data collection of which its feasibility and willingness depends on the company.

The Business Cycle Canvas is based on the extensive analysis of current modeling tools by Mentink (2014) and concentrates on the understanding of the different loops (e.g. reuse, remanufacturing, recycling). Depending on the company and the possible cycles there are different canvases possible are shown in Appendix 7.2, usually looking similar to the butterfly diagram (Figure 2-2) (Mentink, 2014). Understanding the different cycles is important when moving towards circular business models, however the Business Cycle Canvas requires an understanding of numerous and often complex cycles and how value is created for each actor in the supply chain (Antikainen & Valkokari, 2016).

As a result, the framework of Lewandowski (2016) may be the most practical and applicable for companies, and is therefore used in this research.

### 2.5.2 BMC vs CBMC

Since the BMC and CBMC build on the same framework, comparisons of its similarities and differences can be made easily. In the overview on the next page (Table 2-2) each ‘building block’ or component of both canvases are compared based on the findings of Lewandowski (2016). In essence, the CBMC focuses on product design, cycling possibilities and reducing waste, while creating value for the consumers in innovative ways (Lewandowski, 2016). By adding take-back management to the canvas, Lewandowski (2016) places an increased responsibility on the producer.

*Table 2-2. Comparison of the BMC and the CBMC*

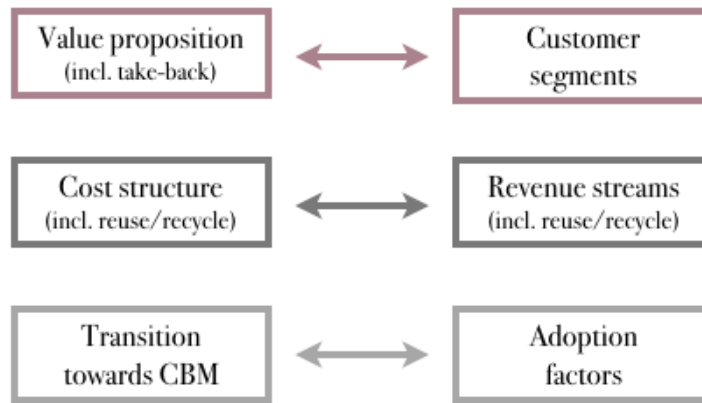
Component of BMC	What it means in a linear BMC	What it means in a CBMC
<b>Value propositions</b>	Seek to solve the problems and satisfy the wants and needs of their customers	<ul style="list-style-type: none"> <li>• Modular design of products choosing materials that enable product-life extension, recycling, cascading, reusing or safe disposal</li> <li>• Services offered enhance product-life extension, recycling etc.</li> <li>• Customers are incentivized to bring products back or the company remains ownership of the products</li> </ul>
<b>Customer segments</b>	The different groups of people or organizations that the organization aims to reach and create value for	(Similar to BMC)

<b>Channels</b>	The ways the organization communicates, delivers and sells value propositions	Implement virtual channels where possible (i.e. online shops, online customization).
<b>Customer relationships</b>	Type of relationship the organization seeks to establish and maintain	Building and maintaining relationships with customers in order to eliminate waste (e.g. produce on demand/vote, social marketing strategies)
<b>Revenue streams</b>	Results from successfully provided value proposition to customers	Several circular propositions for revenue streams such as PSS, take back schemes, and/or remanufacturing. Economic viability is necessary
<b>Key resources</b>	The required assets to make the business model work	Choosing materials and products that create less harm for the environment (e.g. no chemicals, recyclable or biodegradable materials, recycled materials, energy from renewable resources)
<b>Key activities</b>	Most important activities the organization needs to do to make the business model work	Key activities in CBM could be applied in different ways: <ul style="list-style-type: none"> <li>• Increasing performance</li> <li>• Appropriate product design</li> </ul>
<b>Key partnerships</b>	Partners that enable or provide execution of the business model through providing activities or resources	Collaborate closely and influence stakeholders across the value chain to move towards circular products and finding solutions together. Move beyond partnerships to pre-competitive collaboration to push the industry further faster. Working together is essential in moving towards a CE
<b>Cost structure</b>	Most important costs required operating the business model	No good examples reviewed in literature on how cost structure can enhance implementation of CE practices. Usually mentioned cost savings or implications in CBM are regarding PSS, reverse logistics/material flow, costs of product developments and investments.
<b>Take back system</b>	(Not part of BMC)	To enable cascading, recycling and reusing, collecting products back from consumers is essential. May require different partners, channels and customer relations
<b>Adoption factors</b>	(Not part of BMC)	Various organizational capabilities and external factors need to support the CBM: <ul style="list-style-type: none"> <li>• Internal factors (team motivation, knowledge and transition procedures)</li> <li>• External factors (recycling technologies, policies, customer habits/opinion, demand)</li> </ul>

*Source: Information derived from 'Designing the Business Models for Circular Economy – Towards the conceptual Framework' (Lewandowski, 2015)*

### 2.5.3 Key success factors

In order for a business model to be successful, it is key that the certain building blocks ‘fit each other’ (Osterwalder & Pigneur, 2010): the key success factors of a business model (Osterwalder et al., 2005). Moving from a linear to a circular business model, companies should consider the following key success factors, Figure 2-5 on the next page (Lewandowski, 2016). First and foremost, the value proposition (including the incentive for the take-back system) should match the customer needs (Osterwalder et al., 2005). Secondly, similar to any business model, the revenues should not only cover the costs but also indicate potential profits (Magretta, 2002). In the case of circular business models, this also concerns the costs and creating revenues of other cycles, such as reuse and recycle (Linder & Williander, 2017). Thirdly, when moving towards a circular business model, it is key that the company “anticipates and counteracts” the internal and external factors (Roos, 2014).



*Figure 2-6. Key success factors: the fit between different building blocks*  
*Source: Adopted from 'Designing the Business Models for Circular Economy – Towards the conceptual Framework' (Lewandowski, 2015)*

## 2.6 Barriers to textile recycling

In order to gain an enhanced understanding of the textile industry, it is useful to know which barriers currently hold back the industry from increasing textile recycling, and has been researched in-depth. Elander & Ljungvist (2016) conducted an extensive research regarding these challenges and asked stakeholders to rank 43 challenges on its impact level (small, medium or high). The eight most pressing challenges according to the stakeholders (fashion brands, recyclers, collectors) are presented below (Table 2-3). The study conducted by Watson et al. (2017) compiled the input from ten fashion brands that use recycled textiles and/or have a take-back system in place. The challenges from both studies are categorized for the purpose of getting a better overview on the type of challenges the industry is facing.

Studying the post-retail responsibility of brands, and more specifically drivers, opportunities and challenges to reuse and recycling, Kvant Hass (2014) identified additional challenges. Companies see reverse logistics as a challenge due to the lack of knowledge and limited experience with collection, redistribution and recycling of their products (Kant Hvass, 2014). Moreover, consumers are often unaware of what happens to their discarded clothes and its (environmental) impacts causing companies to question the whether new and innovative business models will be accepted by consumers (Kant Hvass, 2014). Finally, developing new reuse and resell models poses new challenges (but also creative opportunities) regarding marketing, retail and redistribution (Kant Hvass, 2014).



Table 2-3. Barriers for industry stakeholders to increase textile recycling by category

Barriers to increase textile recycling				
	Technology	Cost	Design	Other
Elander & Ljungvist (2016)	<ul style="list-style-type: none"> <li>Lack of recycling technology for mixed fibers</li> <li>Lack of chemical recycling technology</li> </ul>	<ul style="list-style-type: none"> <li>Lack of incentives for investments in textile recycling</li> <li>Higher market prices for recycled textile fibers</li> </ul>	<ul style="list-style-type: none"> <li>Presence of plastic prints on textile products</li> <li>Use of mixed fiber types in textile products</li> <li>Preseence of spandex/lycra/ elastane in textile products</li> <li>Lack of purity of input textiles for recycling in terms of fiber type (mono-fiber fabrics)</li> </ul>	
Watson et al. (2017)	<ul style="list-style-type: none"> <li>Lack of recycling technologies</li> <li>Lack of automated sorting technologies</li> </ul>	<ul style="list-style-type: none"> <li>Maintaining economic competitiveness</li> </ul>	<ul style="list-style-type: none"> <li>Retaining durability and quality of products (no compromises)</li> <li>Products not designed for recyclability</li> </ul>	<ul style="list-style-type: none"> <li>Origin of fibers unknown</li> <li>Lack of communication between brands and suppliers</li> </ul>

Source: Adapted from Elander & Ljungvist (2016) and Watson et al. (2017)

## 2.7 Policy landscape

The second research question aims to find out which policies could stimulate textile recycling. Therefore, this section maps out the policy landscape around textile recycling in order to explore which policies could help overcome some of the challenges and increase textile recycling. However, as mentioned previously, there is a lack in literature available that identifies or assesses a variety of policies that have the potential to increase textile recycling, see Table 1-3. Therefore, the literature review regarding policies supporting textile recycling (other than Extended Producer Responsibility and Green Public Procurement) is mostly based on a study conducted by Elander et al. (2017), hence the research and method are briefly introduced.

Based on a literature review, Elander et al. (2017) developed a longlist 27 of policy instruments that promote textile recycling. Interestingly, that this study adjusted policies from other industries to fit the textile industry. Five policy experts from different institutes in Scandianiva ranked these 27 policies against a set of criteria, and a shortlist of ten policies was created. Stakeholders in the industry confirmed the shortlist and shared their insights of aspects such as main challenges and important aspects in design (Elander et al., 2017). As a result, Figure 2-7 was created, providing a schematic overview of the policies categorized by administrative, economic, informative and other measures. All policy instruments included in Figure 2-7 are briefly explained in Appendix 6-2, including an example of each policy (when available), opportunities and potential barriers of the policy. The following section will select the most relevant policies, which will then be discussed more extensively.

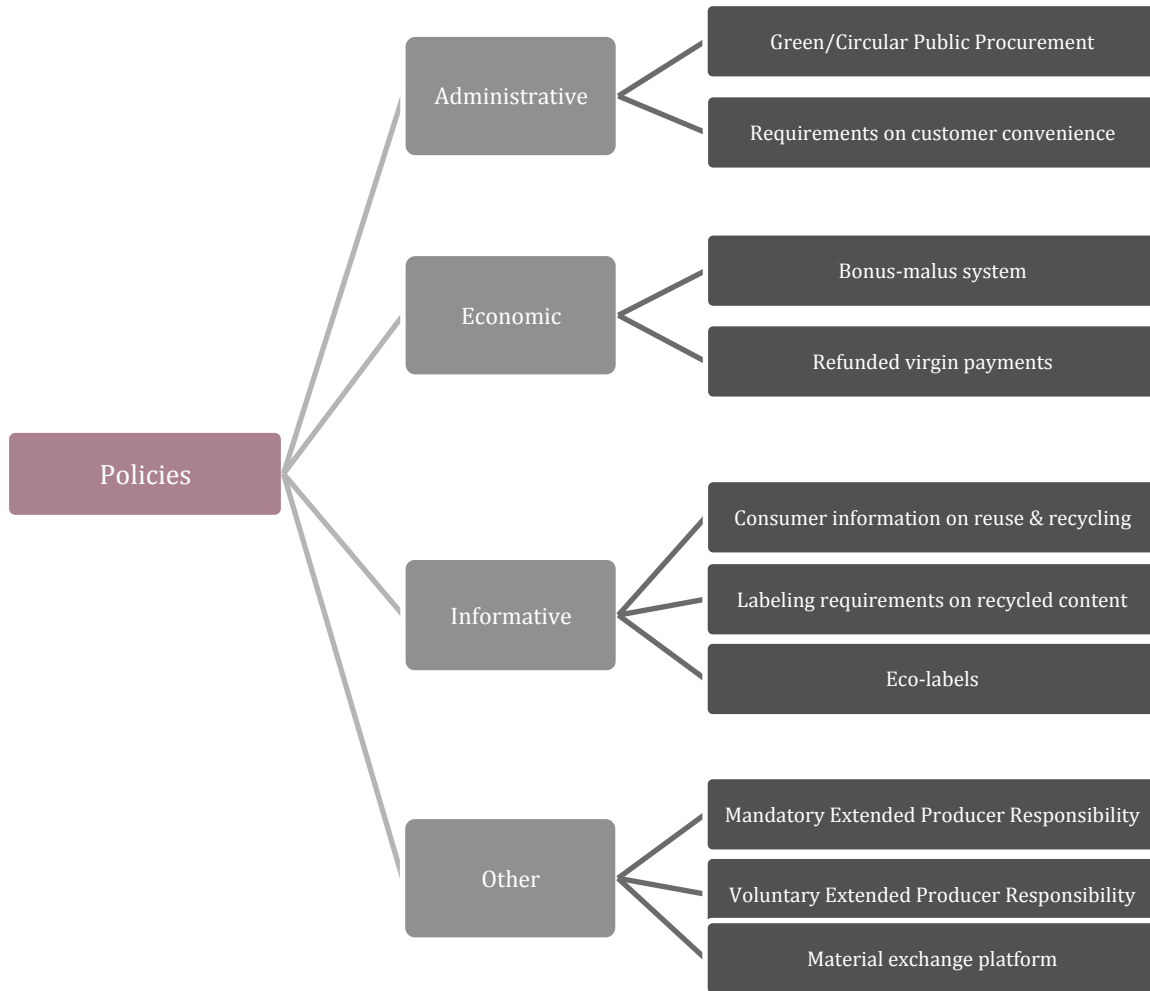


Figure 2-7. Map of policies promoting textile recycling  
 Source: Own Work, Information obtained from 'Impact assessment of policies promoting fiber-to-fiber recycling of textiles (Elander et al., 2017).

## 2.8 Selection of policies

The study conducted by Elander et al. (2017) involved a policy workshop where stakeholders (fashion brands, collectors, sorters and recyclers) were asked to share their insights on the policy measures of the shortlist on different criteria including: largest potential impact to increase textile recycling, feasibility of the policy, and rank which policy is of highest priority. The author compiled the findings and developed a visual aid summarizing the results of the study, see Figure 2-8. The directions of the arrows indicate the highest average score for impact and feasibility. There is no distinction of the level of impact or feasibility among the policies that overlap each other in the diagram.

Mandatory Extended Producer Responsibility (EPR) was among all groups in the workshop ranked as 'highest priority'. The policy instruments identified as 'priority' (marked in grey) indicate that they also scored high but lower than Mandatory EPR. Figure 2-8 shows that, according to the stakeholder insights, Green Public Procurement (GPP) has potentially large contributions, seems feasible and is of priority. While there is a consensus that mandatory EPR has the highest priority. The fact that in literature the most researched policies to stimulate textile recycling are EPR and GPP (Table 1-3) could indicate as well that these

policies are most relevant. All policies that are expected to create a large positive impact, see top half of Figure 2-8, are briefly introduced in the following sections.

Dahlbo et al. (2017) found that industry stakeholders favor voluntary EPR over mandatory EPR. GPP is a very accepted policy instrument but its use should be increased in order to make an impact (Dahlbo et al., 2017). Additionally voluntary EPR is explained based on the results of Dahlbo et al. (2017).

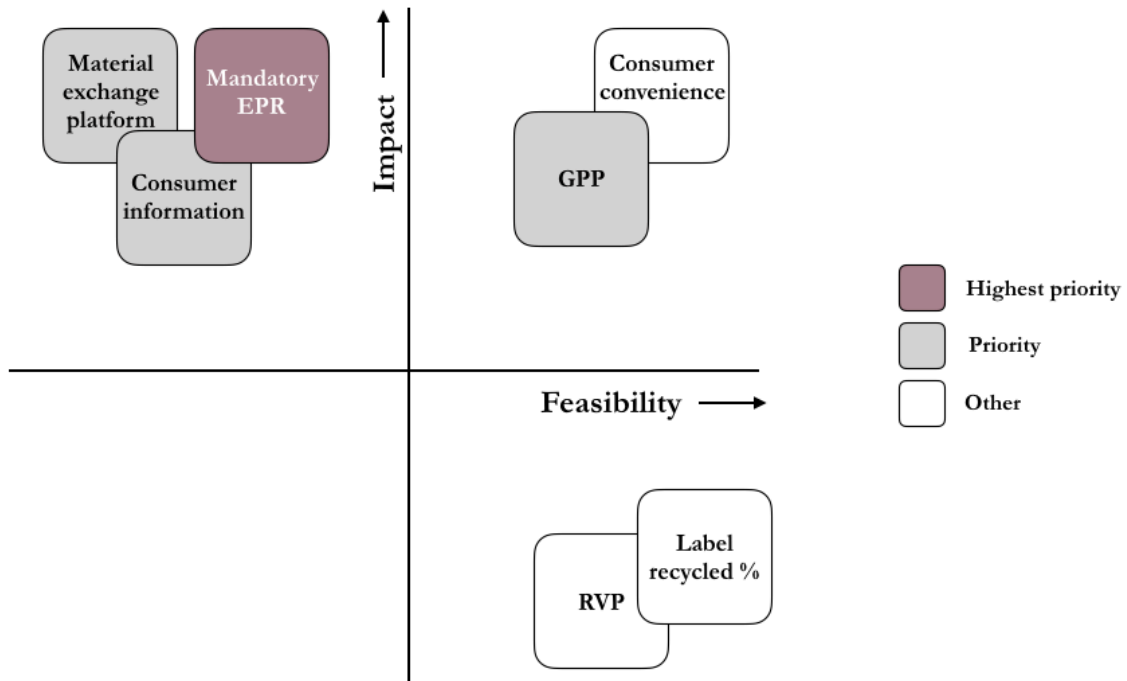


Figure 2-8. Stakeholder insights on anticipated impact and feasibility of the policies  
 Source: Own Work, Information obtained from (Elander et al., 2017)

### 2.8.1 Mandatory Extended Producer Responsibility

Extended Producer Responsibility (EPR) is a policy that aims to reduce environmental impacts across the entire life cycle of products through the extension of producer responsibility (Lindhqvist, 2000). Under EPR producers are responsible (physically and/or economically) for the collection, treatment, and disposal of their post-consumer products (Bukhari, Carrasco-Gallego, & Ponce-Cueto, 2018; OECD, 2001). Producers are incentivized to change the product design and develop recycling techniques. Through mandatory EPR legal requirements on producers are established, whereas voluntary EPR usually consists of producer initiatives that negotiate agreements due to market pressure (Elander et al., 2017).

Examples Mandatory EPR: Take-back requirements, financing mechanisms reflect actual cost of recycling/contribute to development of recycling technologies, preparation for reuse or recycling (Elander et al., 2017; Watson et al., 2014). EPR for textile products is currently implemented in France and is discussed in the following section.

Table 2-4. Summary of opportunities and barriers regarding Mandatory EPR

Opportunities:	Barriers:
<ul style="list-style-type: none"> <li>• Improves resource efficiency, both upstream and downstream</li> <li>• Incentivizes change in design to enable textile recycling and reduce waste</li> <li>• Improves collection systems</li> <li>• Enables economies of scale</li> </ul>	<ul style="list-style-type: none"> <li>• Fashion brands prefer voluntary EPR over a mandatory one</li> <li>• Lack of supply of textiles to recycle would discourage producers to invest in textile recycling technologies</li> </ul>

Source: Information summarized from Elander et al. (2017)

### **EPR in France**

In 2007, France introduced a EPR instrument for textiles, linen and shoes and is still the only European country that has implemented EPR (Bukhari et al., 2018). Companies that put new clothes and other textiles on the French market, i.e. manufacture, distribute and import, are now held responsible for recycling or proper disposal of their products. There are two ways that companies can comply with the legal obligation: (i) contribute financially to a third-party producer responsibility organization (PRO) or (ii) by setting-up an own take-back scheme approved by the French public bodies (Bukhari et al., 2018). Since the implementation, there has been one PRO consisting of 29 organizations including: general large retailers; fashion retailers; direct and online retailers; manufactures and wholesalers; and apparel industry associations (Bukhari et al., 2018). In 2016, the PRO collected a financial contribution from its 4476 members, which put 564.000 ton of textiles on the French market that year. The financial contributions are based on the expenses of the previous year and vary for different sizes of the products. According to Bukhari et al. (2018), the use of recycled textiles is encouraged by an annual tariff reduction for companies that use recycled fibers made from textiles, linen or shoes. A 50% discount of the yearly tariff is given to products that contain a minimum of 15% post-consumer recycled fibers or materials, and 25% discount when products include 30% pre-consumer recycled fibers. Companies that annually generate maximum revenue of €750.000 or sell no more than 5000 items, contribute a fixed tariff (Bukhari et al., 2018).

Regarding the collection of the textiles, the PRO requires monitoring the different channels of collection, sorting and recycling (Bukhari et al., 2018). Textiles that arrive to the sorting facilities are registered, then sorted and recycled. There are 18 sorting facilities in France, and 14 facilities outside France (mostly in Belgium and the Netherlands) who can receive financial supports when certain efforts are made to increase the sorting capacity (Bukhari et al., 2018). For recyclers, subsidies may be provided the following criteria are met: more than 90% recovery rate (percentage of total collected items diverted from landfill and incineration); more than 20 % recycling rate (percentage of sorted, not wearable materials); less than 5% landfilled or incinerated (of collected and sorted materials).

The EPR scheme provided the French authorities with €17.2 million, which is an overage of €0.0067 per piece and €28.7 per ton (Bukhari et al., 2018). These revenues were used to cover the expenses of implementation of the policy, most of the money was spend on: financing projects, subsidies local communities for consumer-awareness campaigns, and subsidies to sorting organizations. As shown in Figure 2-11, the collection rate has been increasing since 2006, on average 13%, which may show that the EPR policy has been successful in increasing the amount of textiles collected (implementation of EPR was in 2007) (Bukhari et al., 2018). However, there is room for improvement within the policy instrument. For instance, the 50% discount on the tariff does not cover administrative costs to declare the items and the certification of the origin of the recycled materials used (Bukhari et al., 2018). As a result, it is not feasible for fashion brands to report on their recycled textiles and obtain a financial benefit.

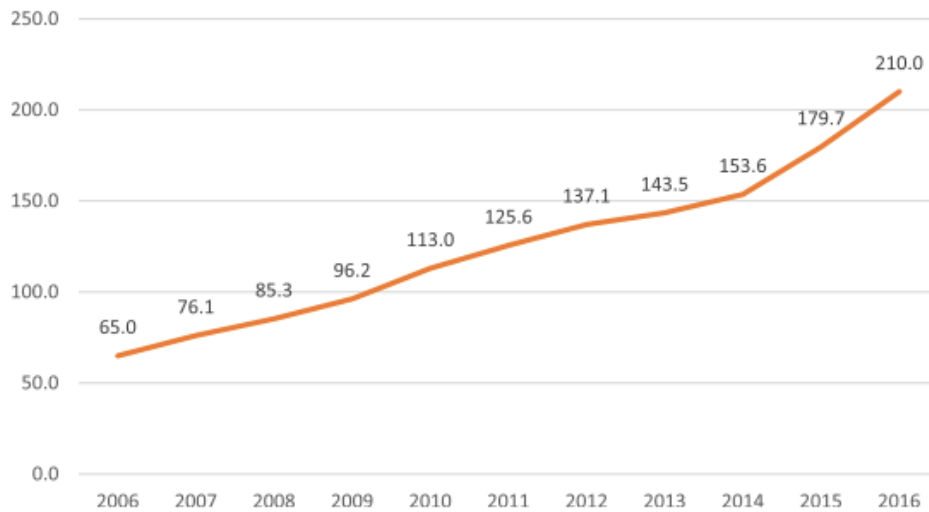


Figure 2-9. Annual increase in collection of textiles in France (in thousand ton)  
 Source: (Bukhari et al., 2018)

### 2.8.2 Voluntary Extended Producer Responsibility

Voluntary EPR is similar to Mandatory EPR, however, stakeholders can voluntarily decide if they want to be responsible for their products at end-of-life (Elander et al., 2017). The scheme is often initiated by producers and the brands can decide whether they commit and to what extend (Elander et al., 2017). While industry prefers voluntary EPR over mandatory EPR, this policy measure may create an unfair level playing field. Additionally, brands that do not join the commitments are likely to still receive benefits without putting in the resources, the so-called free riders, such as the development of recycling innovations (Dahlbo, Aalto, Eskelinen, & Salmenperä, 2017; Elander et al., 2017).

Example: The commitments of the GFA may be an example of voluntary EPR, aiming to achieve upstream and downstream improvements. While the targets are individual and thus different per brand, it does push fashion brands to make improvements. However, it seems that no system has been set up to achieve, for instance, higher collection rates, thus whether it is really EPR is questionable.

### 2.8.3 Green or Circular Public Procurement

Through Green Public Procurement (GPP) public bodies use their purchasing power to incentivize the development of environmentally friendly products and services. GPP compares the environmental impact throughout the life-cycle of comparative products (Elander et al., 2017). Potentially, cost savings can be achieved when the life-cycle costs, and

not just the purchasing price, is considered (OECD, 2018). Since public bodies are purchasing the goods or services, it is important to find a solution that is not only assessed on environmental aspects, but should also be cost-effective (European Commission, 2008b).

The European Commission (2017) published ‘Public Procurement for a Circular Economy’ in which it explains that Circular Public Procurement (CPP) acknowledges the role public bodies can play to support the shift towards a circular economy. CPP is where public authorities focus on sourcing products or services that seek to provide closed energy and material loops across the supply chain, while reducing or avoiding the environmental impacts and waste creation across the entire life-cycle (European Commission, 2017).

Example: Set criteria for minimum proportion of recycled materials used in the products.

Table 2-5. Summary of opportunities and barriers regarding GPP

Opportunities	Barriers
<ul style="list-style-type: none"> <li>• Demand for recycled textile fibers will increase</li> <li>• Competition with products using only virgin fibers may increase if public bodies prioritize the criteria of recycled content in products</li> </ul>	<ul style="list-style-type: none"> <li>• Use of recycling criteria only possible if there is a sufficient supply of recycled textiles</li> <li>• Limited influence as the criteria to choose for products containing recycled textile fiber is just one of the many criteria</li> <li>• Price and durability are priority in public procurement, therefore only effective if the products containing recycled are durable and price competitive</li> <li>• Lack of knowledge at public bodies to set minimum level requirements</li> </ul>

Source: Information summarized from Elander et al. (2017)

### GPP in the Netherlands

The Netherlands developed a government-wide program: “A Circular Economy in the Netherlands by 2050” (Government of the Netherlands, 2016). The Dutch government set a target to reduce 50% of the use of primary raw materials by 2030 (Rengel, 2017).

The Dutch Ministry of Defense uses large amounts textiles, but knowledge on the possibilities of using recycled textiles and its quality was lacking. Therefore, as a foundation the tender, a market dialogue was organized, providing the Ministry with knowledge from suppliers and experts (Rengel, 2017). The tender was released in 2015 for sourcing textile products containing a minimum of 10% recycled textile fibers for 53.000 green overalls, 10.000 washcloths and 100.000 towels (Rengel, 2017). Two Belgian companies were awarded with the contracts and offered towels containing 36% of recycled cotton and 14% of recycled cotton in the overalls. A third-party certification validates whether the products contain the promised percentage of recycled content (Rengel, 2017).

The Rijkswaterstaat (part of the Ministry of Infrastructure and the Environment) contracted the company Dutch Awareness for the supply of caps, polo-shirts, raincoats and fleece jackets for lock stewards that supervise the waterways in summer (Rengel, 2017). The products are made from 100% recyclable polyester, have a good performance and can be recycled into the same products for the next year, up to eight times. For the raincoats a mix with virgin material is necessary to achieve sufficient strength.

### 2.8.4 Consumer information on reuse and recycling

This policy instrument requires consumers to be informed about for instance: textile consumption; reuse and recycling; their role to bring the textiles separated to collectors; and where to collect (Elander et al., 2017).

Table 2-6. Summary of opportunities and barriers regarding consumer information on reuse and recycling

<p><u>Opportunities:</u></p> <ul style="list-style-type: none"> <li>Increased consumer knowledge about textile recycling and their role in the system can lead to an increase of collected (recyclable) garments</li> </ul>	<p><u>Barriers:</u></p> <ul style="list-style-type: none"> <li>Different target groups require different information</li> <li>Consumer knowledge may be improved but this does not mean their purchasing behavior changes</li> <li>To be effective, other policies have to be implemented in conjunction to this policy e.g. improve infrastructure for collection of textiles</li> </ul>
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Source: Information summarized from Elander et al. (2017)

### 2.8.5 Material Exchange Platform

At the moment the communication and information sharing among sorters and the fashion industry is lacking (Ellen MacArthur Foundation, 2017). One of the main obstacles for collectors and sorters is to find buyers and receive high value for the sorted textiles. While on the same time, fashion companies are in need of large-scale high quality recycled textile fibers to be able to incorporate a larger degree of recycled fibers in their products (Elander et al., 2017). Thus there is a clear information gap between sorters who need to find buyers, while fashion companies say the opposite, i.e. there is a high demand from their side for recycled textiles (Elander & Ljungkvist, 2016). Creating a (web-based) platform connects suppliers and buyers, and facilitate exchange and resale’s of collected, sorted and recycled textiles (Elander et al., 2017).

Example: Circle Economy created such a platform, the Circle Market (Circle Economy, 2018a).

Table 2-7. Summary of opportunities and barriers regarding a Material Exchange Platform

<p><u>Opportunities:</u></p> <ul style="list-style-type: none"> <li>Solves the lack of communication between sorters and the fashion brands, and in turn addresses market inefficiencies</li> <li>Potential to increase both supply and demand of recycled textiles</li> <li>Provides statistical data improving insights in the textile industry</li> </ul>	<p><u>Barriers:</u></p> <ul style="list-style-type: none"> <li>Important to assure the quality of traded materials, e.g. through third-party certification</li> <li>Observed difficulties from other material exchange platforms has shown that companies are reluctant to provide information</li> <li>In order to reach enough users, the platform has to be advertised which may be costly</li> </ul>
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Source: Information summarized from Elander et al. (2017)

### 2.8.6 Requirements on customer convenience

One way to increase the amount of textiles collected is to make it more convenient for customers to return their end-of-life textiles, for instance by implementing requirements for municipalities to have collection points in certain proximity from the houses or mandating retailers to take-back clothes at end-of-life (Elander et al., 2017). The aim of this policy

measure is to lower the proportion of textiles ending up in mixed municipal waste and increase the collection rates (Elander et al., 2017).

Example: Increase proximity between collection points and consumers; require retailers to provide collection possibilities.

*Table 2-8. Summary of opportunities and barriers regarding Requirements on Customer Convenience*

<u>Opportunities</u>	<u>Barriers</u>
<ul style="list-style-type: none"><li>• Increase collection rates and supply of post-consumer textiles, while lowering proportion of textiles in mixed waste</li><li>• Improves convenience for consumers</li></ul>	<ul style="list-style-type: none"><li>• Consumers may still neglect textile separation</li><li>• Convenience preferences differ among consumers</li><li>• Urban and rural areas require different collection systems</li><li>• To be effective, this policy should be implemented in conjunction with other policies, such as providing information to consumers on importance of textile separation</li></ul>

*Source: Information summarized from Elander et al. (2017)*



### 3 Method

The purpose of this research is two-fold: (i) find how an increase in textile recycling can be stimulated through adjusting business models of fashion brands and (ii) explore which policy measures are suitable for pushing textile recycling from niche to mainstream. As stated previously in section 1.5, the two research questions are:

**RQ1: How can fashion brands increase the use of recycled post-consumer textiles through adjusting their business models?**

**RQ2: Which policies are needed to increase textile recycling and the use of recycled post-consumer textiles?**

#### 3.1 Research approach

Answering the research questions requires a rounded and real-world understanding of the post-consumer textile recycling market and the challenges and opportunities industry stakeholders experience. The variable-based approach is suited to gain a holistic, real-life perspective (Yin, 2014). Due to the non-disclosure agreement with Circle Economy, all companies need to remain anonymous and results are aggregated.

This research is of exploratory nature, a method used to find out “what is happening, to seek new insights, to ask questions and to assess phenomena in a new light” (Robson, 2002). The research takes an exploratory variable-based approach due to the limited information available on: how fashion brands have made efforts to increase textile recycling, which challenges and opportunities the brands experienced, experiences of other stakeholders that influence textile recycling, and which policies have the potential to stimulate textile recycling (see section 1.4). This research discusses three variables with each stakeholder: design for recyclability, take-back management and the use of recycled textiles. The data collection of this study was conducted in two phases, see Figure 3-1, and are explained in the following sections.

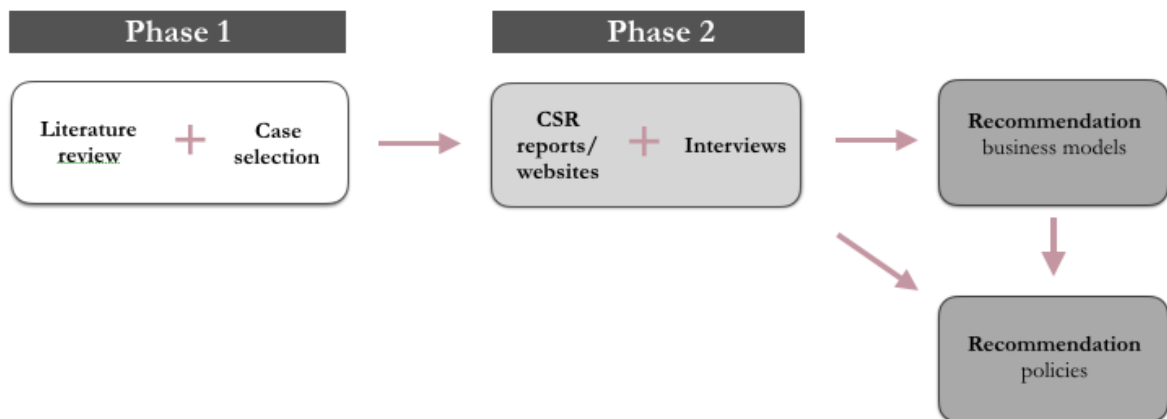


Figure 3-1. Visual representation of research process

#### 3.2 Phase 1

##### 3.2.1 Literature review

Preliminary research was conducted through the collection of secondary data providing the foundation of the research by explaining relevant concepts such as circular business model innovation, to map out policies related to textile recycling, and establish recycling terminology used in this study. The secondary data is presented in the literature review. The data obtained

addressing the first research question are based on the circular economy concept and commonly used and recognized frameworks to ensure that fashion brands can understand and use the suggested adjustments to the business model. As identified in section 1.4, Figure 1-2, the literature available on policies stimulating textile recycling is limited. The findings of Elander et al. (2017) are most complete, extensive and based on policy experts and stakeholder insights, and therefore used as leading source in answering the second research question.

### **3.2.2 Case selection**

Fashion brands that use recycled materials can provide insights into their experiences, how they created value, and which challenges are holding them back from increasing the use of recycled textiles. Obtaining these insights from multiple fashion brands can bring us closer to the understanding of how business models could be adjusted to increase the use of recycled textiles by brands (RQ1). Besides, knowing the challenges they are facing helps to identify which policies could stimulate textile recycling (RQ2).

Therefore, this research selected fashion brands that met the following criteria: *the fashion brands use recycled textiles or actively tried to, through for example pilot programs*. The reason for this is to capture real life experiences rather than anticipated experiences, therefore it is vital that all fashion brands either had experiences with implementing circular strategies to increase textile recycling and/or set up pilot programs. The network of the Fibersort project was a project starting point as most of the brands connected to the project do use recycled textiles. Besides, being part of the Fibersort network with the aim to develop this technology resulted in the fact that brands were more willing to be interviewed. Most stakeholders interviewed were from the Fibersort network, one brand was obtained through the authors' own network.

Additionally, interviewing textile recyclers that provide recycling output to fashion brands could help understand: to what extent textile recycling is feasible for fashion brands, the difference between recycling post-industrial and post-consumer, where and how recyclers source their recycling input. Thus, high-value textile recyclers are also included in this study.

Collectors and sorters are relevant to this research to: understand the current collecting and sorting processes and check information derived from literature, discuss how take-back systems can be improved.

Whereas policy advisors can provide the much needed insights into policies related to textile recycling, what we can learn from France's example, and discussing the selected policies.

## **3.3 Phase 2**

### **3.3.1 Interview preparation**

A total of 24 stakeholders were contacted through email, which resulted in 16 interviews. Phase 1 provided the author with sufficient information to set the variables and develop the interview guides. The key variables discussed with each stakeholder are: use of recycled textiles or textile recycling, post-consumer garment collection, and design clothes that can be recycled. Prior to each interview the author reviewed the Corporate Social Responsibility (CSR) reports and websites to get a clear understanding of the companies efforts and targets towards the fixed variables: textile recycling, clothes collection and design of garments. This helped the interviewer to ask more specific questions about the initiatives of the cases without losing time on questions that can be found online. As a result, the interview guide was adjusted before each interview and additional questions were included per case.

### 3.3.2 Semi-structured interviews

Qualitative data was collected by conducting 16 semi-structured one-to-one interviews, see Table 3-1. The interviews consisted of open-questions only, aiming to not influence any of the responses. In some cases probing questions were asked to help the respondents. The interviews were held over a period of six weeks, mostly through skype, but in some cases in-person. The duration of the interviews varied between 30 minutes and 1 hour, depending on the availability of the interviewees. Each interview was treated as an individual case. A fixed set of variables were discussed in each interview (use of recycled textiles, collection of garments and design), complemented by questions relevant to the particular case. The interview guide for the policy advisors is based on preliminary research regarding the policy landscape around textile recycling, the preliminary selection of the policies, and two country examples of the selected policies (see literature review).

Table 3-1. Overview of selected cases and interviews

#	Stakeholder group	Collection method	Timing	Duration
1	Recycling expert	Skype interview	Jul-2018	30 min
2	Collector, sorter, recycler	Skype interview	Jul-2018	45 min
3	Policy advisors	Phone interview	Aug-2018	1h.15min
4	Fashion brand	Skype interview	Aug-2018	45 min
5	Recycler, Fashion brand	Phone interview	Aug-2018	1h
6	Fashion brand	Skype interview	Aug-2018	45 min
7	Fashion brand	Phone interview	Aug-2018	30 min
8	Fashion brand	Face-to-face interview	Aug-2018	45 min
9	Fashion brand	Skype interview	Aug-2018	1h
10	Fashion brand	Phone interview	Aug-2018	30 min
11	Fashion brand	Skype interview	Aug-2018	30 min
12	Fashion brand	Skype interview	Aug-2018	30 min
13	Recycler	Face-to-face interview	Aug-2018	45 min
14	Fashion brand	Phone interview	Aug-2018	30 min
15	Recycler	Phone interview	Aug-2018	30 min
16	Fashion brand	Skype interview	Sep-2018	1h

The job functions from the interviewees ranged from sustainability managers and directors to material technicians, business development, marketing & brand specialists, designers, founders and policy advisors.

The geographical area of the sample size varied from case-studies based in the NWE region (56% or 9 cases), other countries in Europe (19% or 3 cases), and a few based in the continent North-America (25% or 4 cases).

#### **Fashion brands**

The interviews of semi-structured nature, allowed the interviewer to divert from the questions when new ideas or experiences are brought up. Due to the non-disclosure agreement between the author and Circle Economy, the interviewees are aggregated, generalized and grouped, and no specific information on the companies is communicated. For instance, the stakeholder

group ‘fashion brand’ may include: start-ups, outdoor brands, high-end brands, fast-fashion brands, webshops, occasional wear, etc.

### Recyclers

A total of four recyclers were interviewed, each of them significant size or relevancy in the market. The group ‘recycler’ can range from mechanical, chemical recyclers, and intermediaries (working closely with a range of recyclers), processing different textile materials, but all generating post-consumer recycled textile fiber. Some recyclers could also manufacture clothes, others only produced yarn.

### Collector/sorter

Although only one ‘collector, sorter, recycler’ was interviewed, due to its size and relevancy, the data collected is relevant to this research.

### Policy advisors

The policy advisors interviewed are provided real-life examples of current fashion brands they conduct pilot programs with as well as how the Netherlands and other countries currently view the policy instruments selected in the literature review.

### 3.3.3 Data analysis

Analyzing the data, a narrative approach was taken where the context of each brand was revised individually and different experiences and responses were taken into account (Dudovskiy, 2018). In line with the non-disclosure agreement, the qualitative data is aggregated to secure the confidentiality of each participant and company. All interviews are recorded (under permission) and transcribed. To increase the reliability of the data, the answers of the interviews were often compared to the CSR reports, websites and webshops. For instance when a brand states they use mostly mono-fibers, garments in the webshop were assessed on fabric content.

Codes were developed by assessing the first two or three interviews per stakeholder group. The developed and applied codes, through manual selective coding, allow categorization of data and comparison among the cases. The fashion brands are categorized into market segments and company sizes. The specifics of the categories are presented in the tables below.

Table 3-2. Fashion market segments

Category	Price range (EUR)
Luxury	> 315
Affordable luxury	156 - 315
Bridge	96 - 155
Mid-market	41 – 95
Value	21 - 40
Discount	< 20

Source: *The State of Fashion 2017*, McKinsey&Company (Amed et al., 2016)

Table 3-3. Company size categories

Company category	Staff headcount	Turnover (EUR)
Small	< 50	≤ 10 million
Medium-sized	< 250	≤ 50 million
Large	250 - 1000	51 - 99 million
Extra large	1000 >	>1 billion

Source : *What is an SME ? (European Commission, 2018)*

### Fashion market segments

The categorization fashion market segments is chosen to see if patterns can be found regarding the price segment the brand is in. For instance, to find out if there is a correlation between brands that sell high-end clothes and the use of recycled textiles, as these are more expensive and possibly more feasible for higher-end brands. Likewise, it can be interesting to see whether brands that sell less expensive clothes are able to use recycled materials.

Market segments in the fashion industry can be categorized based on a Sales Price Index<sup>4</sup> looking at prices for a standard basket of products (Amed, Berg, Brantberg, & Hedrich, 2016). Due to the variety of products brands offer with price ranges often exceeding the categories, this categorization method is not set in stone but rather provides a good indication of which market segment the brands are in by assessing the ‘standard basket of products’. In order to indicate the market segment of each brand, the basket of products in this study are: sweater, dress, trousers, top. When a brand did not have its core products within these product categories, the price of the core products (e.g. jackets) were compared to the prices of the same product from other brands. Table 3-2 provides an overview of the price ranges for each category. Figure 3-3 presents the number of fashion brands in each category.

In this study, most brands (7/11) are in the higher-end markets, but on average not higher than € 350 (luxury). Three brands have average price ranges of the ‘standard basket of products’ between € 156 – 360 (affordable luxury), four brands sell their garments on average for prices between € 96 – 155 (bridge), and two brands in the category value selling the standard products on average between €21 – 40.

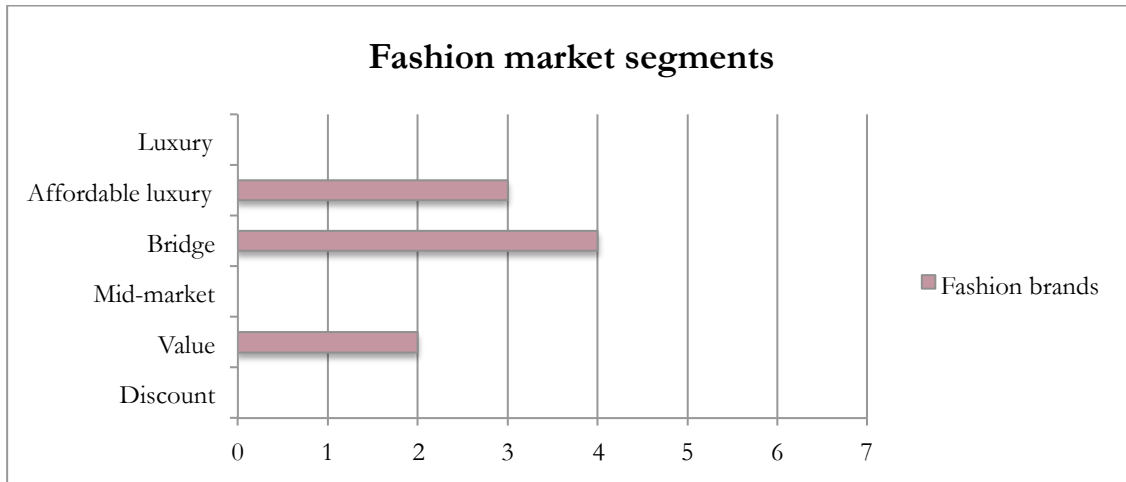


Figure 3-2. Categorization of fashion brands by fashion market segment  
 Source: *The State of Fashion 2017*, McKinsey&Company (Amed et al., 2016)

### Company sizes

The category company sizes is included to gain insight into whether small or large brands have different opportunities and challenges when implementing circular strategies (or trying to). For example, it is probably different for large brands to set up a take-back system than for small brands, as well as the volume of clothes they receive back from the customers. Also minimum order quantities may play a different role for brands of different sizes.

<sup>4</sup> "The Sales Price Index a range of prices for a standard basket of products within each segment and company's home market". *The State of Fashion* (2017). McKinsey&Company.

According to the definition of the European Commission (2018c) there would be four small brands and seven large brands, and no medium-sized, see Table 3-3. However, the author sees a big difference in the turnover and staff headcount between two of the large companies (>1 billion EUR) and the other five (under 500 million EUR). Companies with a turnover greater than 1 billion could have different possibilities and challenges than companies with a turnover lower than 500 million EUR. Therefore, an additional company size category is added: ‘extra large’ companies with a turnover greater than 1 billion, and staff headcount of over 1000 employees (see Table 3-3). The graph below (Figure 3-3) presents the number of fashion brands per company size.

In this study, there are four small brands with a revenue lower than €10 million, no medium sized brands, five large brands have a turnover between € 50 – 99 million, and two brands have a turnover greater than 1 billion.

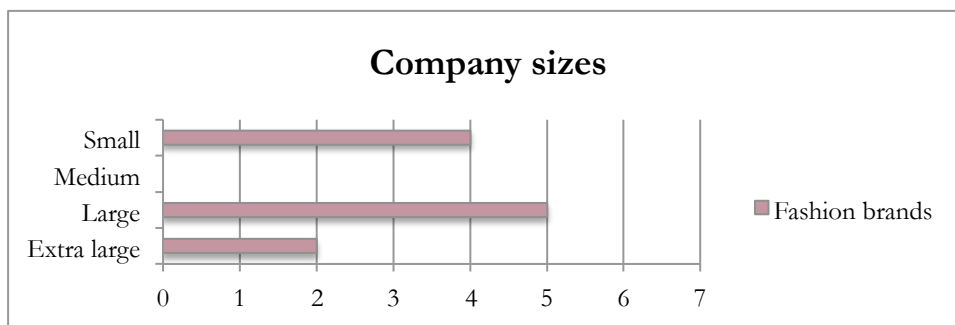


Figure 3-3. Categorization of fashion brands by company size

## 4 Findings

### 4.1 Key circular strategies

The literature review obtained in phase 2 helped the author to identify which circular strategies are crucial for brands to implement in order to increase high-value textile recycling.

In a circular economy, products are designed in a way that materials can be captured at high-value at end-of-life, and uses these materials in new products to minimize both waste and resources needed (Achterberg et al., 2016; Esposito et al., 2018). Materials can be captured at various levels i.e. through reuse, remanufacturing and recycling (Bocken et al., 2016). In practice this means that fashion brands that want to become fully circular need to: (i) take-back their the brands post-consumer garments, (ii) recover these materials into the production of new garments, and (iii) design the clothes in a way that they are reusable, repairable, and/or recyclable, see Figure 4-1 (Watson et al., 2017) .

Through analyzing the results it became apparent that while all brands actively tried to increase textile recycling, no brand has implemented a perfect circular business model or system. Meaning, while sustainability may be at the core of most cases in this study, none of the companies fully implemented a circular business model, but rather components of CBMs, and in this research referred to as ‘circular strategies’. When companies only implement one or two of the three circular strategies, it is not a circular system. This research explored if and how fashion brands implemented the three circular strategies, with the aim to ultimately find how business models could be adjusted to increase textile recycling (RQ1), the stakeholders’ experiences will help to identify to which challenges could be addressed by which policies (RQ2).

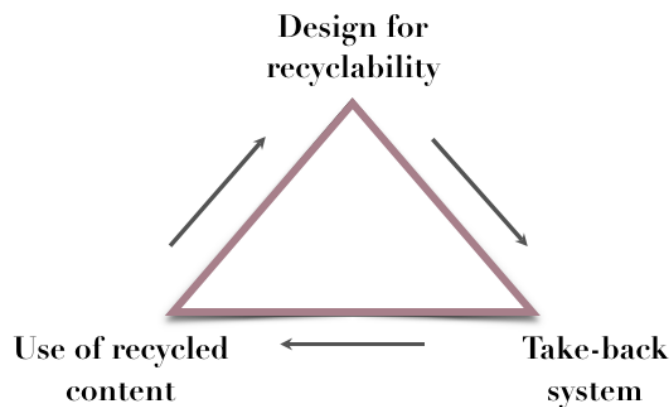


Figure 4-1. The three circular strategies identified to increase textile recycling

None of the brands has implemented all three circular strategies. Table 4-1 (see next page) shows the specific circular strategy implemented per case (marked in pink), and which cases are conducting a pilot or setting up the strategy at the moment (light grey). Nearly all brands use recycled textiles, the one brand that is indicated at not using recycled content does use recycled polyester from plastic bottles. As the table shows, while brands may do great efforts trying to incorporate recycled materials, only one of the cases in this study moved towards designing their garments to be recyclable. Looking at take-back management, around half of the cases has a system in place or are currently setting one up. The following sections present the results, potential patterns, relationships and trends of the three circular strategies.

Table 4-1. Case-studies and their implementation of the three circular strategies

Case #	Design for recyclability	Take-back management	Use of recycled content
1	No	No	Pilot
2	Yes	No	Setting it up
3	Setting-up	Yes	Yes
4	No	No	Yes
5	No	Yes	Yes
6	No	Setting-up	Yes
7	No	No	Yes
8	No	Yes	Yes
9	No	Setting-up	Yes
10	No	Yes	Pilot
11	No	No	No
<b>% Implemented</b>	<b>9%</b>	<b>36%</b>	<b>55%</b>
<b>% All</b>	<b>18%</b>	<b>45%</b>	<b>82%</b>

\*Note: Brands marked in pink currently implemented the strategy, grey refers to brands that are setting-up this strategy.

‘All’ refers to brands that implemented, conduct a pilot, or setting-up a circular strategy.

#### 4.1.1 Design for recyclability

The first step in the circular clothing system is to design products that can be reused or recycled at end-of-life. One brand designs for recyclability and one brand is setting up a production plant focused on producing clothes that can be recycled (Table 4-1). The brand pays attention to material use (natural and mono-fibers where possible), minimizes the use of synthetic fibers, uses biodegradable dyes and limits additives (e.g. zippers).

Table 4-2. Design for recyclability among case studies

Case #	Design for recyclability	Long-lasting	Company size	Fashion market segments
2	Yes	Yes	Small	Affordable luxury
3	Setting up	Yes	Large	Affordable luxury
4	No	Yes	Large	Affordable luxury
8	No	Yes	Large	Affordable luxury
10	No	Yes	Large	Affordable luxury
7	No	Yes	Small	Bridge
9	No	Yes	Small	Bridge
11	No	Yes	Large	Bridge
6	No	No	Small	Bridge
1	No	No	Extra large	Value
5	No	No	Extra large	Value

\*Note: Brands marked in pink currently design for recyclability, dark grey refers to brands that are setting-up to design for recyclability, and light grey high-lights the brands that design for long-lasting



### Recyclability vs. durability

When discussing design for recyclability, most brands in market segments affordable luxury and bridge (see Chapter 3, page 42 – 44) brought up the internal dilemma whether they should design durable and long-lasting products, or products that are possible to recycle. These brands expressed that mono-fibers lack in quality and choice and that their main challenge is to create beautiful, long-lasting items products that also can be recycled. Eight out of eleven brands design for durability, including the one brand that designs for recyclability also. Brands also explained that for some garments it is extremely difficult or impossible to design it in a way that the garments can be recycled, with the current available technologies.

The brands that are in the market segment ‘value’ say that the main issue for designing for recyclability is the lack of recycling and sorting technologies. Though, both brands are working on training all their designers to design for circularity.

### Need for blends

Most brands in this study indicate their preference to use natural fibers over synthetic fibers where possible. For some brands, natural fibers are seen as higher-quality material than synthetic fibers. However, the brands across market segments mentioned that there is a need for blends to achieve desired quality (e.g. durability, handfeel, and/or performance). It is expected by various interviewees (brands and recyclers) that future recycling technologies will soon extend the number of materials and blends that can be separated and recycled through chemical processes. Five brands (cases: 2, 4, 7, 8, and 9) stated to focus on creating garments made from only one type of fabric (mono-fabrics) which can already help for recyclers, especially when technologies develop.

### Surplus fabrics

In contrary to ‘design for recyclability’ two brands, including the one designing for recyclability, applied the circular strategy ‘re-use as material’ where a large portion of the garments are made from surplus fabrics or deadstock from other companies. While it is great that these fabrics are recovered and not wasted, the content of the fabrics are usually unknown which makes it more difficult to high-value recycle at the end-of-life.

### Increasing recyclability

A couple of brands state that they are currently training designers to design for circularity. Each interviewee expects that recycling technologies will arise in the next 5 years. This will increase the number of materials that can be used which makes it easier for brands to design beautiful and unique garments that meet quality and performance requirements and can be recycled.

Table 4-3. Key messages from interviews regarding design for recyclability

Design for recyclability		
Themes	Brands	Recyclers
Long-lasting	<ul style="list-style-type: none"> <li>Struggle to make long-lasting products that are recyclable</li> </ul>	<ul style="list-style-type: none"> <li>Quality of yarn decreases when mechanically recycling blends, while blends are often necessary to make long-lasting products</li> </ul>
Surplus fabrics	<ul style="list-style-type: none"> <li>Using post-industrial waste (scraps and deadstock) for the production new clothes</li> <li>Often results in unknown content of fabrics and increases difficulty to recycle</li> </ul>	<ul style="list-style-type: none"> <li>Major barrier to increase textile recycling is unknown content of fabrics</li> </ul>

<b>Blends</b>	<ul style="list-style-type: none"> <li>• Increased preference for natural fibers, often seen as higher-quality</li> <li>• Need for blends in order to achieve the right quality (e.g. durability, handfeel, performance)</li> </ul>	<ul style="list-style-type: none"> <li>• In the case of cotton high percentages of one fiber (at least 80-90%) is recyclable, but highest quality is achieved when using mono-fiber fabrics</li> <li>• Using mono-fabrics has the potential to recycle the garments in the future</li> </ul>
<b>Increasing recyclability</b>	<ul style="list-style-type: none"> <li>• A couple of brands currently train designers for circularity, more brands should follow</li> <li>• Future sorting and recycling technologies will make design for recyclability easier</li> <li>• Brands do not want additional restrictions in materials use through e.g. policy</li> </ul>	<ul style="list-style-type: none"> <li>• Brands are aware that a change in design is needed and they are working on it, new innovations will make this possible</li> </ul>

### 4.1.2 Take-back management

In a circular system, products are collected at end-of-life to either be reused or recycled (Ellen MacArthur Foundation, 2017). From the eleven brands, four brands do have a take-back system in place where they collect garments from their own brand (cases 3 and 8) or any type of garment from any brand (cases 5 and 10), see Table 4-2 on the next page. Two brands (marked in light-grey: cases 6 and 9) are currently setting it up (have set up collecting points and incentive). Table 4-2 identifies that from the four brands, three brands are in the affordable luxury segment and all brands have a large or extra large company size. The two brands that are currently setting up the take-back system (marked in light grey) are both small and in the bridge market segment (see Chapter 3, page 42 – 44 for information on market segments).

All brands are in consensus that clothes should be collected at the end-of-life, as well as that a mix of organizations should work together to achieve this, mainly brands themselves, municipalities and collectors. Charities receive most of the post-consumer garments at the moment because consumers often think that their clothes ends up with people in need. However, as stated previously, and confirmed by the collector/sorter, charities use the collected garments as main revenue point and sell it to countries in Eastern Europe, Africa or Asia.

The brands that have not yet implemented a take-back system state that reasons:

- First want to have recycling technologies in place before setting up a take-back system
- Complexity of international infrastructure, don't want to ship of waste across borders

### Collection points

All brands that do have a take-back system in place or setting one up, take-back clothes in their stores, or in the retail stores their garments are sold (brands of small company size), see Table 4-3. Two brands (cases 3 and 8), additionally to collecting in-store, also offer customers the option to ship their garments at end-of-life to two addresses within the nation of the brands' main market. The take-back system of the brands that offer shipping is only limited to one country because the main market is national and the brands do not want to ship waste across borders. The brands that are operating internationally partnered with a collector, and brands that operate mostly nationally have their own take back system in place, collecting their own brand. Collectors and sorters receive their input usually from charities, but also from municipalities and brands.

Table 4-4. Take-back management among case-studies

Case #	Take-back system	Collect garments of	Collecting points	(Expected) mass collected	Company size	Fashion market segments
3	Yes	Own brand	In-store and shipping	Not enough	Large	Affordable luxury
8	Yes	Own brand	In-store and shipping	Not enough	Large	Affordable luxury
10	Yes	All brands	In-store through collector	Not enough	Large	Affordable luxury
5	Yes	All brands	In-store through collector	-	Extra large	Value
9	Setting-up	All brands	In-store in retail stores	Not enough	Small	Bridge
6	Setting-up	Own brand	In-store in retail stores	Not enough	Small	Bridge
2	No	N/A	N/A	Not enough	Small	Affordable luxury
7	No	N/A	N/A	-	Small	Bridge
4	No	N/A	N/A	-	Large	Affordable luxury
11	No	N/A	N/A	Not enough	Large	Bridge
1	No	N/A	N/A	-	Extra large	Value

\*Note: Brands marked in pink currently have a take-back system in place, grey refers to brands that are setting-up a take-back system.

### **Incentives**

All brands in this study use a small financial reward as a tool to incentivize consumers to return clothes, ranging from \$5 to <10% discounts. Most of the brands in this study are focused on becoming more sustainable and realize that a voucher only stimulates consumption, while the brands aim to slow down fashion. These brands state that there has been a lot of brainstorming within the companies of other forms of incentive, but in the end the only way to get the customer put effort in returning the clothes probably has to be linked to a financial incentive, and it has to make sense for the company too. The collector/sorter also explains to have moral problems with the voucher system and suggests more creative marketing campaigns to incentivize consumers to feel good about returning their clothes.

### **Lack of awareness**

According to the collector, whether consumers donate clothes to municipalities or charities, the garments usually end-up at the same place: by collectors and sorters. The difference is though that consumers view the municipality collection points more as waste, whereas charities receive the better quality garments. The collector suggest that there should be more communication and education around textile collection, because consumers are now simply unaware that they throw away products that can be used in new products.

While the brands offer shipping labels and try to make it as easy as possible for consumers, the extra effort still seems to be a major challenge in receiving post-consumer garments. One brand points out that this may be resolved when we educate customers. Often consumers do not know that their piece of worn garment can be reused or recycled, which probably links to the fact that consumers don't want to make the extra effort to return garments to collection points.

### **International collector**

Two brands partnered with an international collector who takes care of the entire infrastructure around collecting the clothes, resale of wearable's, recycling of non-wearable's. There is a critique to partnering with a large collector and sorter. The interviewees that do not work together with a large collector and sorter argue that the collected garments are not processed to the highest potential where: (i) wearables are resold to countries in Eastern-Europe, Africa and Asia where a large portion ends up as waste; (ii) non-wearables are downcycled or incinerated. In other words, the non-wearables collected by a large collector and sorter are usually only downcycled where it loses a lot of value which cannot be recovered. The two brands that are partner with a large collector and sorter do state that the company does 'the best they can' and that they invest a lot in technology to improve the quality and value of recycling output because it is in their own interest.

The international collector/sorter in this study confirms that around 55-60% is sent to other countries, and more specifically states that around 40% is sold to Africa, 10-15% to Eastern Europe, and the remaining overseas to usually Asia. While the brands in the study mostly create garments that are last-long, the collector and sorter states that there is a decrease in revenue on second-hand sales due to lower quality garments. Overall, the quality of the garments have been decreasing mainly due to fast-fashion. Diminishing revenues incentivizes the collectors and sorters to develop recycling technologies to remain profitable, and potentially reduces the garments sent to Eastern-Europe, Africa and Asia.

### **Low collection rates**

When brands have a take-back system in place, they collect the clothes and store them until they collected a critical mass which is often the minimum order requirement from recyclers, in order to process the garments. Seven brands in this study mention not to be receiving enough mass or expecting so when they would set up a take-back system, see Table 4-3. The remaining four brands did not mention anything about this, which could imply that it is not an issue for them, but could also simply not have come up. The seven brands from company sizes small and large, in market segments affordable luxury and bridge, explained that this was due to different reasons: (i) small brands are too small to generate enough mass; (ii) higher-end brands received customer feedback that consumers feel a barrier to return their clothes because it is still of such high quality or have become attached to the garments; (iii) limited amount of stores, thus offer shipping options but seems a larger barrier; (iv) lack of customer awareness. As part of their target, one brand explains that all employees in store are encouraged to explain the take-back system to the consumers, yet they also face low collection numbers. Most of the brands offer a small financial incentive to stimulate consumers to bring back their garments, the low-collection rates however suggest that this incentive is ineffective.

In this study, it seems that the extra-large brands in the lower market segment (value), do not have or do not expect to have an issue with collecting enough mass. The reason for this may be that, unlike for higher segment brands, the garments of companies in the 'value' segment are easier to donate or give back than when garments are still of really good quality. Additionally, one interviewee stated that it is known consumer behavior to be more attached to garments that are more expensive and of higher quality (emotional and physical durability).

Eventhough most brands state that the effort and logistics is not worth it for the mass they receive, several brands mention that the take-back scheme has been great for marketing purposes and expect that it led to an increased consumer engagement and awareness.

### Increasing collection rates

In order to increase collection rates, the brand states that, government and brands have to both work on increasing consumer awareness and customer convenience. Educating consumers (either through marketing by brands or government campaigns) on their role in the system and how they can increase textile recycling is vital in order to increase collection according to the collector. Brands state that it is important to gain a better understanding of the consumer perspective and how much effort they are willing to put into returning garments could help brands find a solution to increase the collection of garments.

An increased amount of collection points from a mix of organizations (charity, municipality and brands) can increase the consumer convenience for a wide range of consumers. The collector/sorter gives an example of increasing customer convenience through adding textile deposit systems next to the more common bottle deposits. It can be helpful to have a variety of collection systems in place to address different people with different habits. According to the collector/sorter, brands and retailers currently do not have the infrastructure in place to have collection boxes in-store and store the collected items at warehouses, but that has to change because brands also play an important role in collection of garments. The policy instrument EPR could help to increase collection rates as is the case for France. Though, according to the collector we have to learn from the example in France and create new business models instead of charity driven collection and sorting systems.

Table 4-5. Key messages from interviews regarding take-back management

Take-back management		
Themes	Brands	Collector/sorter
General	<ul style="list-style-type: none"> <li>All brands are in concensus that clothes should be collected by a mix of organizations, mostly municipalities and brands. Critical towards charities</li> <li>Brands without a take-back system in place: first want to be able to recycle the collected garments and face challenges to not ship waste across borders</li> </ul>	<ul style="list-style-type: none"> <li>Agrees with brands but also benefits by charities as a supplier of post-consumer textiles</li> </ul>
Collection points	<ul style="list-style-type: none"> <li>Collect all brands or own brand through in-store bins or shipping labels</li> </ul>	<ul style="list-style-type: none"> <li>Receive post-consumer textile waste from charities, municipalities and brands</li> </ul>
Incentives	<ul style="list-style-type: none"> <li>Most brands have financial incentives range from \$5 - &lt;10% discount on the next purchase</li> <li>Brands recognize the vouchers incentivize consumption, but do not know any alternative solution at the moment</li> </ul>	<ul style="list-style-type: none"> <li>Financial incentives such as vouchers stimulate consumption, while creative marketing campaigns can make consumers feel good about returning their clothes at the end-of-user-life</li> </ul>
Lack of awareness	<ul style="list-style-type: none"> <li>Consumers are unaware of the potential of their worn garments, which likely lowers the willingness to put an effort in returning any items</li> </ul>	<ul style="list-style-type: none"> <li>Collected garments through charity is of better quality than when collected through municipalities</li> <li>Consumers are not aware that different collection points (i.e. charity, municipality and international collectors) end-up at the same sorting facility and have the same faith</li> </ul>

<b>International collector</b>	<ul style="list-style-type: none"> <li>• Takes care of entire infrastructure, for large international brands probably the only solution at the moment</li> <li>• Collected garments are usually either resold to other countries or, downcycled or incinerated</li> </ul>	<ul style="list-style-type: none"> <li>• Opportunity to high-value recycle the collected garments due to declining profits from resale resulted in investing in the development of recycling technologies</li> <li>• Confirms that around 60% is resold and sent to other countries</li> </ul>
<b>Low collection rates</b>	<ul style="list-style-type: none"> <li>• Most brands face low collection rates due to: small company size, emotional/physical durability, limited collection points, and lack of customer education</li> <li>• Regardless the low amount of garments collected, the take-back scheme was good for marketing purposes, consumer engagement and consumer awareness</li> <li>• Small financial incentives are apparently not effective</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of customer education</li> <li>• Lack of collection points</li> </ul>
<b>Increasing collection rates</b>	<ul style="list-style-type: none"> <li>• Governments and brands need to work on increasing consumer awareness and customer convenience, through education and more collection points</li> <li>• Finding an alternative incentive that is more effective in encouraging consumers to return their garments</li> </ul>	<ul style="list-style-type: none"> <li>• Different organizations need to work together and increase the collection points</li> <li>• Brands need to develop the infrastructure of reverse logistics</li> <li>• Policy instrument EPR could stimulate collection rates, learn from France's EPR system, and focus on new business models</li> </ul>

### 4.1.3 Use of recycled content

To complete the circular system, the collected non-wearable clothes should be recycled and used in the production of new garments. Ten out of eleven brands, across all market segments, either: use recycled textile fibers; run a pilot program aiming to see the feasibility; or are currently setting up the infrastructure with a supplier (see Table 4-1), excluding the brands that use recycled polyester from plastic bottles or recycled nylon from fish nets. This research categorizes brands using recycled content when recycled textile fibers are incorporated in a portion of the garments (e.g. a collection or one or a few product categories), or in some cases all of the items contain recycled textile fibers.

#### **Post-consumer vs. Post-industrial**

From the seven brands implemented the circular strategy 'use of recycled content', four brands use post-consumer textile waste, whereas the other three brands use post-industrial scraps and surpluses for recycling (see Table 4-4). Brands in the market segment 'affordable luxury' and are large, all use post-industrial textiles, whereas small brands in the 'bridge' segment uses post-consumer textile waste. The reason for this may be that there is currently not enough supply for larger brands to incorporate post-consumer textiles. It is also possible that the use of post-consumer textiles is of higher priority for the smaller brands in this study than the larger brands. Besides, do most consumers even know (and care about) the difference between post-industrial and post-consumer recycled textiles?

At the moment recyclers state that the textile waste they recycle is nearly all from post-industrial waste. While their intention is to use post-consumer textile waste, they state that improved take-back and sorting systems are vital to increase the consistency of post-consumer textiles by i.e. fiber type, quality and color. Improved systems can decrease the large quantities that are incinerated at the moment. For instance, one recycler stated that the quality of the yarn decreases when they recycle blends instead of mono-fiber fabrics. In the case of mechanical cotton recycling, usually a poly/cotton blend can be recycled when it contains a

high percentage of cotton (generally at least 80-90%). The same recycler explained that they face great challenges to recycle post-consumer textiles. Mainly due to the fact that it is often unknown what the garments are made of, as a result they currently recycle over 95% post-industrial fabrics instead of post-consumer garments. Another recycler developed a technology that is able to process nearly all of the post-consumer textile waste, currently only produces one type of textile accessory in two colors.

**Percentages recycled content per fiber type**

Seven brands shared the specific percentage of recycled content available in the garments (either in webshops or during the interviews), ranging between <20% - 85%, see Table 4-3. The ‘extra large’ companies in market segment ‘value’ achieved the lowest percentages of recycled content used: around 15-20%. The companies, both small and large, in the market segments ‘affordable luxury’ and ‘bridge’ use between 40 – 85% of recycled textiles. For recycled wool, 70% seems often to be used by the companies in the market segments ‘affordable luxury’ and ‘bridge’ and designing for long-lasting. Recycled cotton usually has lower percentages, between 15 -30% for jeans and, in this study, up to 40% for sweaters. The brands that have garments containing 100% recycled materials often did blend it with recycled polyester. Material that is recycled most is PET bottles, followed by cotton and wool.

Recyclers share different viewpoints on whether they expect that they and the supply chain can handle an increase in demand for recycled post-consumer textiles. In order to increase recycling it may be better to first focus on increasing the number of garments containing recycled textiles and then focus on increasing those percentages. In this way the supply chain has time to transition to an increasing use of recycled textiles. Recyclers were asked to what the minimum amount incorporating recycled textiles in new garments was possible and still remain high-quality. The recyclers explain that a minimum of 20% for recycled wool, cotton and polyester is certainly feasible at the moment. One recycler states that her the minimum is 25% and the fabrics have been “super successful” in terms of quality, durability and handfeel. A recycler explained that technically garments made out of 100% recycled textiles is possible, but to scale this up and make it economically viable is then a challenge.

Table 4-6. The use of recycled textiles among the case-studies

	Recycled content	Type of textile waste	% Recycled textiles	Recycled material	Fashion market segments	Company size
6	Yes	Post-consumer	50-70%	Cotton 50%, wool 70%	Bridge	Small
7	Yes	Post-consumer	85%	All textile waste mixed	Bridge	Small
9	Yes	Post-consumer	40%	Cotton	Bridge	Small
5	Yes	Post-consumer	<20%		Value	Extra large
3	Yes	Post-industrial	35-80%	Cotton,wool, cashmere	Affordable luxury	Large
4	Yes	Post-industrial	70%	Wool	Affordable luxury	Large
8	Yes	Post-industrial	50-80%	Refibra, cashmere	Affordable luxury	Large
2	Setting it up	Post-consumer	-		Affordable luxury	Small
1	Pilot	Post-consumer	<20%	Cotton	Value	Extra large
10	Pilot	Post-industrial	-		Affordable luxury	Large
11	No	-	-		Bridge	Large

\*Note: Brands marked in pink currently use post-consumer recycled textiles, grey refers to brands that are using post-industrial recycled textiles.

## **Markets for recycled textiles**

The type of garments most often made from recycled textiles among the brands are sweaters (wool and cotton) and jeans (cotton). While socks and home textiles also seem to form a great market for recycled post-consumer textiles. Nearly all brands brought up that jeans are suitable for incorporating recycled textiles while remaining quality due to the thicker yarn that is used for denim.

From the two brands running a pilot to see the feasibility around the use of recycled textiles, one brand (value segment) successfully produced a collection of garments with recycled content. The other brand in market segment 'affordable luxury' faces a problem due to its need for very high quality fibers. The current mechanical recycling technologies shorten the fiber length when the garments are shredded, which makes them unusable for this company to incorporate in its high-quality garments. The brand most likely has to wait until chemical recycling technologies develop of the fiber types they use. Which shows that certain items (i.e. where long fibers are vital) are not yet suited to contain recycled textiles, with the current technologies.

## **Minimum order requirement**

What became apparent during most of the interviews is that the minimum order requirement (MOQ) is an issue for many brands in the uptake of recycled materials. The MOQ for the companies in this study was usually 2.000 kg of yarn. Recyclers do acknowledge this issue but state that this is resolved when an increased demand for recycled textiles leads to economies of scale. Because recyclers clearly state that their main issue is a lack of demand for recycled textiles from fashion brands. While recyclers understand that brands have certain quality and design standards, they are of the opinion that brands should be more flexible and persistent in trying to find the right blend. If brands would like different colors of yarn, they have to order 2.000kg of each color. For brands, especially the small ones, this is certainly an issue. A few brands stated to be interested in some sort of collaboration with other brands in order to make it more feasible to include recycled textile fibers in their garments, such as collectively order the yarn or fabric. In contrary, one recycler stated that collaboration between brands to collectively purchase yarn is not going to happen because brands want their own, unique garments and therefore need their own individual blends.

## **Inconsistent output**

In order to limit the use of additional dyes and chemicals recyclers often recycle batches of garments that have been sorted by color. The color of the yarn will be a blend of the color sorted recycled garments. The color of recycled yarns can therefore vary, and brands often demand color consistency. Different recyclers find that brands have to step up and take responsibility of their business practices and use more recycled textiles and create opportunities through, as they suggest, marketing to tell the story behind, for instance, the collection with inconsistent colors. Understandably, most brands mention that their priority is to create beautiful, and in most cases, long-lasting products and will not compromise that for the sake of using recycled materials. Mechanical recycling, the process used most nowadays, diminishes the quality of the fabrics due to shortening of the fibers.

## **Price**

Towards the end of each interview, after having discussed recycled textiles for a while, a question was asked about the price of recycled textile fibers compared to virgin fibers. Only two brands (market segments: value and affordable luxury) had brought up that the higher price of recycled materials is, besides quality, a major problem for them in switching towards recycled materials. The other brands did not seem to have a pressing issue with the higher



price. Even though price did not seem to come up as a major issue for most of the fashion brands, a recycler states that price is the main barrier for brands to buy recycled textiles. The recycler notes that most of the times brands are not realizing that the price should be compared to dyed virgin yarn. One brand explained that prices of virgin natural fibers are increasingly becoming a risk for fashion brands, wool for instance had tripled in price temporarily. These price changes makes it increasingly interesting to move towards recycled textiles.

Most brands stated that a price comparison is complicated, but usually around organic cotton prices for recycled cotton and a 10-20% mark-up for recycled polyester. Recyclers share the same price comparisons. One recycler states that it is difficult to compare the prices because the price of virgin materials is not the right price since it is not dyed yet which also costs money, and recyclers often deliver yarn with color already. Regarding polyester, according to a recycling expert gas and oil prices have been so low historically that it is hard to compete with virgin polyester. Additionally, a recycler states that environmental and social costs should be included in the price of virgin materials. Looking at the environmental impacts, you can save a lot of money using recycled textiles, when compared to the price of virgin materials the difference is “bizarre”. Also all recyclers and experts state that the prices of recycled materials could be competitive with virgin materials when economies of scale can be achieved. At the moment they lose a lot of time with the smaller order quantities. When they would receive bigger orders they state to be able to do it for nearly the same price.

### ***Vertical integration***

Some brands (mostly small companies) stated the need for a vertically integrated supplier that collects or purchases post-consumer textiles, recycles it into new yarn with the right blend, and produces fabrics and sometimes garments. One recycler explains that currently recyclers often get their textile waste from different sources or they purchase it from ‘sketchy’ textile traders, then send the sorted materials to their recycling plants usually in Spain. This is then shipped to mills in Turkey and probably shipped elsewhere to make the garments. Vertically integrated suppliers can be important when looking at transporting waste across borders, as well as achieving a consistent flow of fabrics made from recycled materials. However, other brands, mainly the larger ones, said that there is no need for a vertically integrated supplier and it may be more efficient if different stakeholders work together. The recycler states that in the supply chain they rather work with suppliers of virgin materials than with recyclers because sometimes there are more issues (i.e. consistency, quality, time, color).

### ***Lack in communication***

One recycler explains that brands usually are in contact with fabric supplier or garment supplier who make the fabric out of the yarn, but brands rarely talk to yarn suppliers themselves. The mill companies are often traditional in the materials they want to use, and they need, according to the recycler, brands to tell them to want to use recycled materials. The mills then need to look for suppliers. Therefore, recyclers in some cases try to create a pull in the market and talk to brands directly.

### ***Lack of transparency***

One recycler explains that the textile waste trading market is currently a ‘shady’ business. The recyclers buy, usually post-industrial, textile waste from traders but overall transparency is lacking. Circle Economy confirms that traders do not want to share the quantity and price of the textiles to remain in charge of the price.

Brands have not mentioned the lack of transparency, probably because they are not communicating with suppliers and especially not the traders.

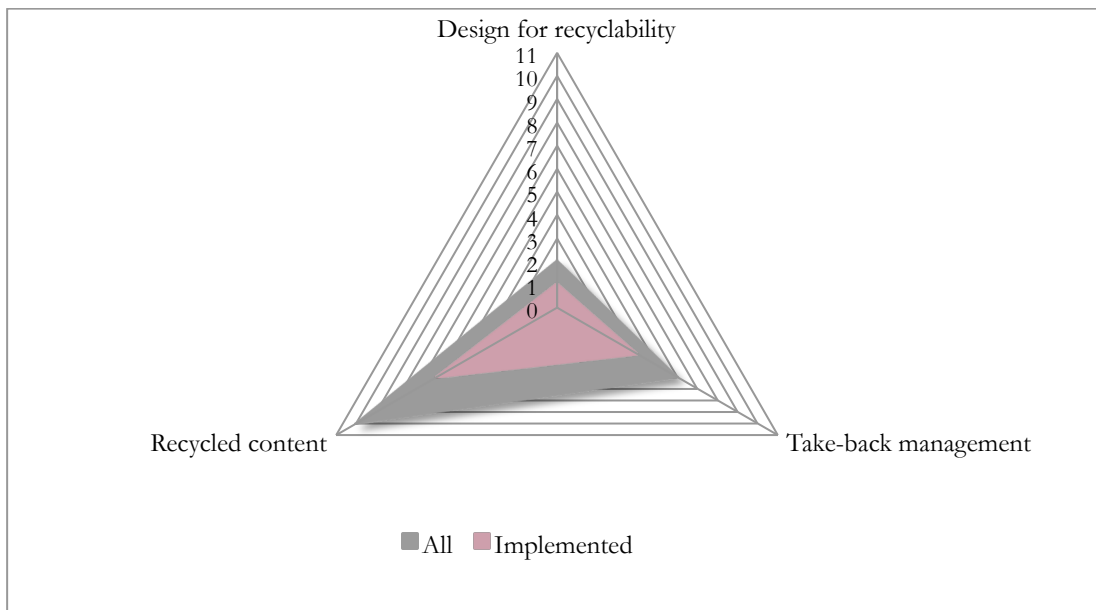
Table 4-7. Key messages from interviews regarding the use of post-consumer recycled textiles

Use of post-consumer recycled textiles		
Themes	Brands	Recyclers
Post-consumer/ industrial	<ul style="list-style-type: none"> <li>Post-consumer recycled textiles are used by small and extra large brands, whereas large brands use post-industrial textiles</li> </ul>	<ul style="list-style-type: none"> <li>Around 95% of the recycled textiles are post-industrial</li> <li>Brands' demand for consistency (e.g. in quality and color) is difficult to achieve with post-consumer textiles</li> <li>Improved collecting and sorting systems are vital to increase the consistency of the supply of post-consumer textiles (color, fiber type and quality)</li> </ul>
Unknown content	<ul style="list-style-type: none"> <li>Content of post-consumer garments from other brands is unknown and makes it very difficult to recycle</li> </ul>	<ul style="list-style-type: none"> <li>Mostly post-industrial mainly due to unknown content of post-consumer textiles</li> <li>Technologies that could identify the content of the fabrics would enable quality assurance and the uptake of post-consumer recycled textiles</li> </ul>
% Recycled content per fiber type	<ul style="list-style-type: none"> <li>Percentages of recycled content per garment varies between 15-85%                             <ul style="list-style-type: none"> <li>Recycled wool sweaters 70%,</li> <li>Recycled cotton for jeans ranges between 15-30%</li> <li>Recycled cotton sweaters 40%</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Uncertain whether the supply chain can handle up-scaling the use of recycled textiles, recyclers share opposite views</li> <li>Start with an increased number of garments that contain recycled textiles and then increase the percentages to give the supply chain time to transition</li> <li>Creating garments that contain at least 20% of recycled wool or cotton and polyester is certainly feasible</li> </ul>
Markets for recycled textiles	<ul style="list-style-type: none"> <li>Type of garments made most: sweaters (wool and cotton) and jeans (cotton)</li> <li>Very high quality garments unfeasible with mechanical recycling</li> </ul>	<ul style="list-style-type: none"> <li>Socks and home textiles</li> </ul>
MOQ	<ul style="list-style-type: none"> <li>Most brands face issues with the MOQs for recycled yarn: 2.000 kg of yarn</li> <li>Few small brands are interested in collaborations with other brands to make ordering recycled textiles more feasible</li> </ul>	<ul style="list-style-type: none"> <li>An increase in demand would resolve the MOQ issue and make recycling more economically viable</li> <li>Collaboration between brands to purchase recycled yarn together will not happen because brands want unique fabrics and need different fabric compositions</li> </ul>
Inconsistent output	<ul style="list-style-type: none"> <li>Brands do not want to comprimize on style, color, quality or durability of the garments when using recycled materials</li> <li>Need consistency of quality and color throughout the collections</li> </ul>	<ul style="list-style-type: none"> <li>Quality diminishes through mechanical recycling, especially when recycling blends</li> <li>Recycling can lower the need for dyes and chemicals, but leads to color inconsistency</li> </ul>
Price	<ul style="list-style-type: none"> <li>Recycled cotton similar to organic cotton prices</li> <li>Recycled polyester 10-20% mark-up</li> <li>Price of virgin fibers are increasingly becoming unstable, wool for instance tripled in price recently</li> </ul>	<ul style="list-style-type: none"> <li>Price is the main barrier for brands to use recycled textiles</li> <li>Price comparison of virgin and recycled fibers is often done wrong, e.g. excluding the costs for dyeing the yarn</li> <li>Economies of scale can lower the prices</li> </ul>

Vertical integration	<ul style="list-style-type: none"> <li>Some small brands indicate the need for vertically integrated supplier, can improve consistency and solving the issue of shipping waste across borders</li> <li>Larger brands express there is no need for vertically integrated suppliers, having different suppliers drives efficiency</li> </ul>	<ul style="list-style-type: none"> <li>Supply chain rather works with suppliers of virgin materials than recyclers due to i.e. inconsistencies, quality, time and color</li> <li>Vertically integrated suppliers are not the solution due to need for uniqueness</li> </ul>
Lack of communication		<ul style="list-style-type: none"> <li>Brands are often in contact with the fabric supplier or garment supplier, but rarely with the yarn suppliers. Traditional mills slow down the uptake of recycled textiles</li> </ul>
Lack of transparency		<ul style="list-style-type: none"> <li>Recyclers explain that the textile waste trades are currently a 'shady' business</li> <li>Not wanting to share price and quantity openly</li> </ul>

The brands in this study are among the industry leaders in using recycled textiles, however the limited implementation of three key circular strategies by the brands becomes visible in Figure 4-2. While seven brands in this study use recycled textiles in the production of new garments, four brands use post-consumer recycled textiles, four brands implemented a take-back management system in place, and one brand designs for recyclability. In the case of the take-back system, clothes can also be collected by other stakeholders such as the municipalities or charity organizations. Designing for recyclability seems to be a major challenge for the brands (in this study) across all market segments. Most brands in this study are focusing on a wider range of circular strategies than the three identified. Aiming to gain a more in-depth understanding of the dynamics around the three key strategies, other trends around textile recycling among fashion brands in this study are identified in the following sections.

Figure 4-2. Implementation of key circular strategies by the number fashion brands in this study



\*Note: 'All' refers to brands that implemented, conducted a pilot, or set up a circular strategy.

## 4.2 Other strategies

While the three previous strategies were discovered through deductive analysis, there were other strategies found inductively (Figure 4-3, on the next page). The strategies were brought up because of the relation to textile recycling, often forming a barrier or driver for the brand to increase textile recycling. The top three strategies (excluding the key strategies) are further reviewed: sustainable materials (11 brands), design for long-lasting (8 brands), driving R&D (5 brands).

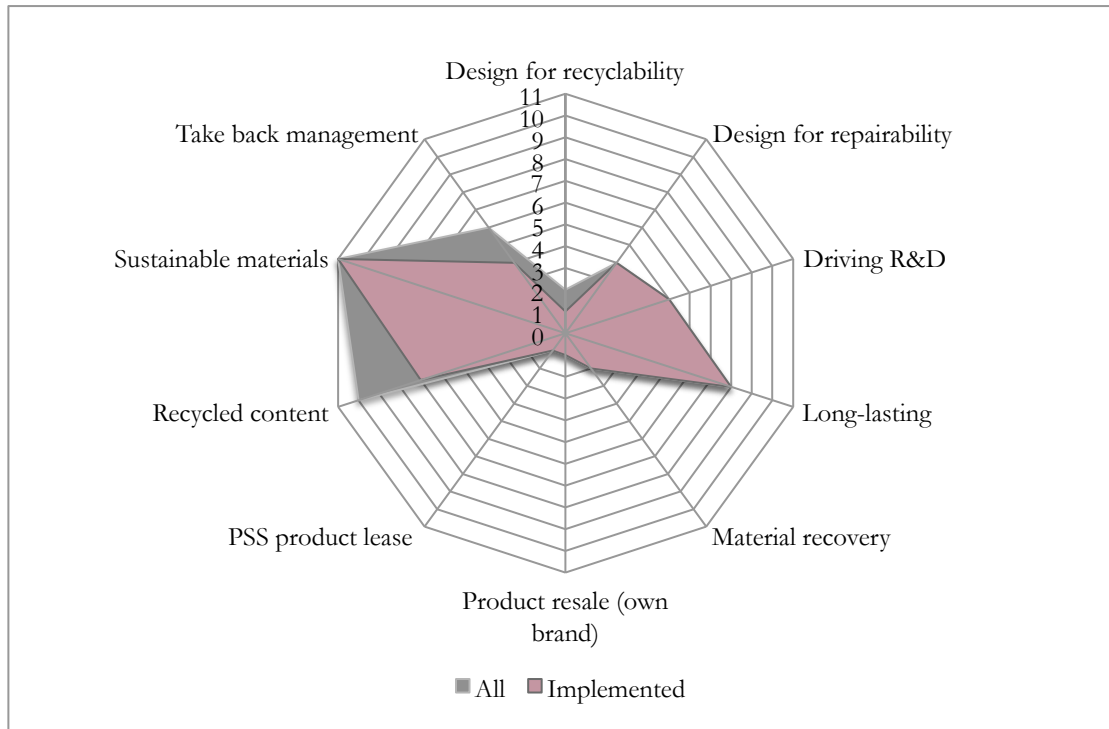


Figure 4-3. All circular strategies brought up in interviews

\*Note: 'All' refers to brands that implemented, conduct a pilot, or setting it up a circular strategy.

With the aim to identify patterns and relationships among the strategies, Table 4-8 (next page) is created using different color shades to highlight patterns. The cases marked in grey are the brands that focus on creating clothes that last for a long time. Within those cases, the ones that have a take-back system in place or are currently setting it up are marked in grey.

### 4.2.1 Sustainable materials

The choice of materials plays a very important role in the fashion industry, all brands mentioned its importance and complexity. The brands in this study noted that materials need to make consumers feel good, be price competitive, last-long, and most importantly look beautiful. Additionally materials often need to provide certain performances such as: warmth in a jacket, lightness in a dress, and stretch in socks. In order to develop the desirable fabrics, fibers are blended, dyed and treated. Materials can be resource intensive (such as cotton) or polluting (e.g. using toxic dyes), but brands also have the option to source 'sustainable materials'. *Sustainable materials* are in this study, and in line with brands' websites and CSR reports, materials that have much lower environmental impact because they are: grown organically (e.g. organic cotton); made from renewable sources (e.g. fabrics made from sustainable certified wood sources); natural fibers only (e.g. cotton, linen, silk, wool); and/or made from recycled materials (e.g. recycled wool or cotton). Sustainable materials are sometimes blended with other fibers to reach the desired quality.

In line with the focus of the companies, all brands in this study do use sustainable materials. The brands in the market segment ‘value’ use sustainable materials in their clothing for one collection or pilot project, while brands in the ‘affordable luxury’ and ‘bridge’ segments focus on mainly (or only) using sustainable materials.

**Type of materials**

The most common sustainable materials brands in this study use are: organic cotton, lyocell (made from celluloses of sustainable wood sources), refibra (mix of lyocell from sustainable wood and post-industrial cotton scraps), and recycled textiles such as recycled wool, cotton, and cashmere. Most brands use recycled polyester and also communicate this as a sustainable material on the website and CSR reports. Four brands mentioned during the interviews that they are seeking alternatives for synthetic fibers because washing plastic-based textiles releases plastics microfibers into the ocean.

Table 4-8. Overview of the strategies per case-study

Case #	Sustainable materials	Long-lasting	Driving R&D	Design for repairability	Design for recyclability	Recycled content	Take-back management	% recycled textiles	Company size	Fashion market segments
2	Yes	Yes	No	No	Yes	Setting -up	No	-	Small	Affordable luxury
3	Yes	Yes	Yes	No	No	Yes	Yes	35-80%	Large	Affordable luxury
4	Yes	Yes	Yes	Yes	No	Yes	No	70%	Large	Affordable luxury
8	Yes	Yes	No	No	No	Yes	Yes	50-80%	Large	Affordable luxury
10	Yes	Yes	No	Yes	No	Pilot	Yes	-	Large	Affordable luxury
7	Yes	Yes	Yes	No	No	Yes	Setting -up	85%	Small	Bridge
9	Yes	Yes	No	Yes	No	Yes	Setting -up	40%	Small	Bridge
11	Yes	Yes	Yes	Yes	No	No	No	-	Large	Bridge
6	Yes	No	No	No	No	Yes	No	70%	Small	Bridge
1	Yes	No	No	No	No	Pilot	No	<20%	Extra large	Value
5	Yes	No	Yes	No	No	Yes	Yes	<20%	Extra large	Value

\*Note: Brands implementing circular strategy ‘long-lasting’ marked in pink, brands that additionally have a take-back system in place or are setting it up are marked in grey

**Materials first**

Looking at Figure 4-3 there may be a relationship between companies using sustainable materials and recycled materials, which are both among the circular strategies implemented most. One brand explains it takes time for the supply chain to adjust towards the use of different materials. This was the case when organic cotton was first introduced, and it’s the same with recycled textiles. Similar to the results in this study it is likely, that in a few years the same number of brands using sustainable materials will also use recycled textiles (see ‘all’ in Figure 4-3). There seems to be a lower barrier to change the materials of the garments, than other strategies where for example a change in design (i.e. design for recyclability or repairability) or change in sales model (i.e. product resale or leasing products) is required (Figure 4-3). Due to the complexity and the discussed limitations recycled textiles bring (e.g.

shorter fibers decreases quality of the fabric, higher price than for virgin materials) you would assume that a lower number of brands use recycled materials in the production of new garments, but the contrary is the case. The reason for this may be that the use of sustainable materials is of higher priority for fashion brands because the reduced environmental impacts they bring which are measurable and easy to communicate with consumers. Another potential reason may be that manufacturing fabric is often outsourced where brands ask suppliers to find a solution for producing fabrics containing recycled materials. Whereas changing the way garments are designed, or change the way products are sold or rented requires more time and resources of the fashion brands themselves (as well as the risks it may bring).

#### **4.2.2 Long-lasting products**

Nearly all case-studies in the 'affordable luxury' and 'bridge' market segments focus on creating products that last for a long time (see Table 4-2 on previous page, marked in grey), looking at both physical durability (designed to endure damage and wear) and emotional durability (creating timeless designs that consumers like to wear for a long time) (WRAP, 2017b). The reason case 6 does not develop clothes that last a long time is because the focus is on creating products from 100% recycled materials (70% recycled textiles, 30% recycled plastic bottles) and faces the challenges with the durability of recycled textiles output. The company expects their garments to currently last a few years, but when recycling technologies improve move to developing longer-lasting products.

#### **Opportunity for reuse**

The brands highlighted in dark grey (Table 4-8) are currently managing the take-back of garments or setting-up its infrastructure at the moment. From the six brands that do have a take-back system in place or setting one up, one brand does not focus on creating products that last long. Similar to what can be expected, there may be a relationship between the companies in the higher-end market segments (affordable luxury and bridge) create long-lasting products, with both physical and emotional durability, resulting in a higher interest in collecting their products because of its potentially high-value when consumers dispose the garments. This relationship is in line with the qualitative data obtained from a few cases. One case states that from the collected items, roughly 50% can be resold right after cleaning the garments as the garments are designed to last long. Another brand explained that the take-back system was set up because of queries from consumers about what to do with their garments when they don't want them anymore but find them still of too high quality to throw away or donate.

#### **High percentage recycled content**

Table 4-8 identifies a potential relationship between the focus on creating products that last-long, the market segment and the percentage of recycled textiles incorporated in garments. Companies in this study, that create long-lasting products in the higher market segments (affordable luxury and bridge), also tend to have a higher percentage of recycled content in its items. Based on previous results (recycled textiles are of lower quality due to the shortened fibers) you would assume that companies creating long-lasting products in the higher market segments, are not able to incorporate high percentages of recycled textiles. Among the case-studies, the contrary seems to be the case: the brands in the affordable luxury and bridge market segments, focusing on creating long-lasting and high-quality products, have achieved the highest percentages of recycled textile content by blending recycled fibers with lyocell, polyester, and elastane. Since these cases give such a high importance to creating long-lasting products, it can be assumed that the items they produce containing recycled materials meet quality specifications and still last-long.

### **4.2.3 Driving R&D**

Many challenges are a result of a lack of available and economically viable sorting and recycling technologies. As a response, five brands in this study are driving research and development (R&D) through heavy investments (2 brands) or research (3 brands). The rest of the brands did not communicate (website or interview) any investments or research efforts, however most brands are connected to the Fibersort Project to help find ways to increase textile recycling. All brands mentioned the need for sorting and recycling technologies to develop.

## **4.3 Policies addressing challenges**

Shifting from virgin materials to post-consumer recycled textile fibers is more challenging but of higher importance due to the reduced environmental impacts (Ellen MacArthur Foundation, 2017; Goldsworthy, 2014; Hawley, 2009; MADE-BY, 2018). Front-running brands (in terms of sustainability) in this study, showed that it is feasible to use recycled textiles, even creating products containing recycled content that are assumed to last long. However, the various challenges to increase textile recycling withholds the industry to move from niche to mainstream. The implementation of policy instruments could enable an increase in textile recycling and the use of recycled textiles. Different studies tried to identify which policies could stimulate textile recycling (shown in Table 1-2). Literature review showed that four policies are ranked as highest priority by industry stakeholders. Due to the limited availability of literature regarding policies that could stimulate textile recycling (Table 1-2), this section aims to confirm whether the key challenges found in this study could be addressed by de selected policies and identify if additional policies should be considered. In doing so, the opportunities of each policy presented in the literature review (section 2.8) are held against the key challenges found in the results (section 4.1, tables: 4-3, 4-5, 4-7), presented in the Table 4-9 below. While policies have the potential to stimulate post-consumer textile recycling, they can only drive technology to a limited extend such as: use part of the revenue from policy instruments for R&D (Bukhari et al., 2018). The column 'technology' is added to indicate which challenges would be addressed by improved technologies.

The table on the next page indicates that EPR has the potential to address six of the current challenges. GPP or CPP could help overcome five barriers and a material exchange platform has the potential to address four challenges. Whereas providing consumer information regarding reuse and recycle theoretically tackles two problems. Most challenges are addressed by one policy only, and therefore all policies appear to be relevant. Interesting is that each policy instrument only addresses the barriers of one key strategy, such as: GPP and a material exchange platform only affects the 'use of recycled textiles', consumer information has the potential to increase collection rates. The only exception is EPR which has the potential to overcome challenges up- and downstream, see Table 4-9. Future technologies have the potential to solve many issues amongst all strategies and make textile recycling (economically) viable. One challenge is outside the scope of most policies: the issue of shipping collected waste across borders. Due to its international nature, its outside the scope of this research, but expected that brands are the ones that have to resolve this issue.

Looking at the Table 4-9 the combination of these exact policies seem to be the perfect package to overcome nearly all barriers, confirming the results of Elander et al. (2017). Of course, these results are mostly based on stakeholder insights and theory and outcomes may vary upon implementation. The degree of success however, will depend heavily on the design of each policy instrument. Despite the limited stakeholder knowledge about the policies, the obtained qualitative data can contribute to considerations and recommendations for the policy designs. The following sections discuss each policy measure based on the information from the literature review and the interviews with all stakeholders, including the policy advisors.

This research aimed to identify which policies are needed to increase textile recycling. Details on the design of the policies is out of scope of this research, however, at the end of each policy an overview of key considerations are included.

Table 4-9. Identification of challenges addressed by selected policies or technology

Identifying which policies could address the challenges							
Key strategy	Key challenges	EPR	GPP/CPP	Consumer information	Material exchange platform	Requirements on convenience	Lack of technology
Design	Struggle to create products that last-long and recyclable						○
	Quality of decreases in mechanical recycling process						○
	Need for blends for quality and performance						○
	Brands need push to design for recyclability	✓	✓				
Take-back	Lack of sorting and recycling technologies lowers brands' participation in take-back						○
	Ship waste across borders issue						
	Low collection rates (due to: )	✓					
	➤ Lack of collection points	✓				✓	
	➤ Lack of consumer awareness/education			✓			
➤ Lack of effective incentive for consumers to return garments			✓				
Use of recycled text	Need for improved sorting to identify unknown content and accurately sort						○
	No compromises, need for recycling technologies to improve output quality and consistency		✓				○
	Most recycled textiles are post-industrial, need for increased use of post-consumer	✓	✓		✓		
	Minimum order requirement for recycled yarn too high, need for economies of scale	✓	✓		✓		
	Price recycled fibers more expensive than virgin fibers	✓	✓				
	Lack of communication among brands and suppliers				✓		
	Lack of transparency in textile waste market				✓		

\*Note: ✓ refers to a policies potential to address a challenge, ○ refers to lack in technology

### 4.3.1 Mandatory EPR

Through extending the responsibility of the producers, EPR has the potential to increase collection rates (e.g. France), and improve resource efficiency upstream as well as downstream (Elander et al., 2017; Tojo et al, 2012; Watson et al., 2014). EPR can set requirements on: collection rates, waste diversion targets, information on collection, collection convenience, collaboration, seeking for more effective collection systems, and requirements on closing the material loop (Elander et al., 2017). Usually a fee is charged to companies putting new clothes on the market and held responsible for proper waste management. The fee usually varies



depending on company expenses of the previous year and products size (Bukhari et al., 2018; Elander et al., 2017). As part of an EPR system a producer responsibility organization (PRO) is set up to monitor different channels i.e. collection, sorting and recycling. Companies can either pay a financial contribution to the PRO for the handling the collection and end-of-life management of the garments or organize such systems themselves.

The EPR system implemented in France is currently mainly focused on the collection of post-consumer textiles. While it is important to increase collection rates, the policy measure could create a larger impact. The policy advisors stated that a circular approach is lacking for EPR system in France, but mentioned that France is currently revising its take-back system aiming to encourage durability and high value recycling.

EPR is gaining increased attention and popularity, the Netherlands publicly announced in June 2018 to explore ways for implementation of EPR in the country. The industry policy proposal is due July 2019. According to the policy advisors, the initial idea was to implement an EPR system in several countries simultaneously. However, other countries are not ready yet to look for ways to implement this policy.

### **Design for recyclability**

The policy measure that covers most challenges is EPR: the only policy (in this study) that incentivizes a change in design. While vital in a circular clothing system, results show that in this study frontrunning brands are lagging behind on designing for recyclability. Brands have valid reasons, mainly the lack of technology to recycle a range of fabrics and prints (e.g. mono-fibers, blends and dyes). However, brands can start to change the design of just certain garments such as t-shirts, jeans and sweaters. For instance, change how a cotton t-shirt is designed to enable recycling, i.e. switch to natural dye, don't add prints or additives and use cotton only. Despite this, only one brand out of eleven does design for recyclability when suitable and possible. Therefore in order to transition towards a circular economy an incentive to drive a change in design is crucial. If the sample of this study represents the the actual fashion brands that are frontrunners sustainability-wise (and more specifically textile recycling), it would mean that the implementation of policy incentivizing the change in design has the potential to create great impact. Since EPR requires monitoring and control, there possibilities on different incentives depending on what will be monitored. For instance, brands could earn a discount on the fee for placing a certain amount of recyclable garments on the market. Since design is so crucial, it may be important to provide the largest discount on garments that are made to be recyclable or biodegradable.

It is important to consider to also stimulate brands to make products long-lasting. This does however add additional challenges in monitoring and enforcement, because how do you test the quality and durability of garments?

### **Collection**

EPR could increase collection rates through setting requirements on take-back schemes. Setting requirements on collection rates incentivize brands to promote clothing take-back through incentives and providing information. However, brands are facing the problems with the low number of garments that are returned by consumers, therefore education will play an important part in the success of this scheme. The brands in this study find that collection should be done by a combination of parties, more specifically: brands, collectors, and municipalities. Some indicate that collection through charity is misleading for the consumers while these garments end-up in abroad, are downcycled, incinerated or landfilled. On the other hand, a collector explains that charities receive higher quality post-consumer garments than municipality bins do due to the limited consumer awareness. EPR usually offers different

options for companies to comply with collection targets. In the case of France companies could either contribute financially through a third party PRO or having brands set up their own take back system which has to be approved by public authorities.

France has shown that EPR could increase the number of collected garments, however according to the collector/sorter, the way it is set up is charity-based and inefficient and suggests to focus on creating new viable business models. Increasing the number of collected garments through improving customer convenience is important, but what does that look like? The collector/sorter suggests to add textile drop off in discount stores such as Lidl and Aldi where consumers currently can deposit bottles. One brand states to offer shipping labels and in-store take-back to try to make it as effortless as possible for consumers, thus how convenient does it have to be for consumers? Several brands believe that possibly consumers are willing to take the extra effort to return their items if they are aware of the importance of post-consumer recycling.

The background research showed that most of the collected garments are incinerated, landfilled, or sold to Eastern-Europe, Africa and Asia. Therefore it is important to seek for a system that incentivizes not only collection rates, but also how the collected garments are processed. Perhaps collection can be incentivized in combination with proper disposal (e.g. reuse, high-value recycling). However, collection may also be incentivized through providing higher discounts on proper disposal of the brands' clothes.

### **Use of recycled textiles**

EPR can provide a discount on the fee for the garments containing recycled textiles. Depending on the ambition of the policy the minimum percentage for garments containing recycled content. The discount can be offered when garments contain at 15% recycled content, with the aim get as many companies as possible on board. Setting a more ambitious targets such as 30%, or even specify for cotton 30% and wool 70%, have the potential to really drive the market, innovations and the uptake for recycled textiles. However, when most companies can't meet these criteria they may be discouraged instead of encouraged. A more feasible percentage could result in a larger number of brands that use recycled textiles and every year or few years this minimum should increase according to market developments. This will also help to create time for the supply chain to adjust towards using more recycled textiles. In France, the criteria is set on 20%, however this is likely to be linked to downcycling.

An increase in demand could result in economies of scale and eventually lower the price for recycled textiles. In the case of France, Bukhari et al. (2018) identified that the discount on the tariff does not cover the costs of declaring the garments and the required certification. Understandably, this discourages the fashion brands to apply for the discount. On the same time, it is important to consider that recycling cotton and wool shortens the fiber length and diminishes the quality of the fibers. With the right blends, the brands in this study have shown that it is feasible to create beautiful, long-lasting products that contain recycled content. Perhaps the first focus could be on products that are shown to be suitable for recycled materials, jeans, sweaters, socks and homegoods.

### **Monitoring and control**

Monitoring and verifying whether the recycled textiles are post-consumer or post-industrial may be challenging. If this is possible in some way a difference in discount could be made depending on the source of input. However, all these percentages need to be monitored and controlled in some way. Therefore, requirements should be set on measurable variables. Perhaps current or future technologies (such as blockchain) could make the monitoring easier

and enabling more ambitious targets. France does distinguish between post-consumer and post-industrial textiles, but available data on effectiveness is lacking. Choosing to focus on one or more product categories may also help to make monitoring and enforcement more feasible. For example, only examining jeans can lead to efficient processes and economies of scale.

**Revenues**

The revenues generated through the fees on garments put on the market provided France with a total of €17.2 million a year, an average of €0.0067 per piece. In France, besides covering the scheme’s implementation costs, the revenues were spend on local consumer-awareness campaigns and subsidizing sorting facilities. Looking at the current market and how little is high-value recycled and how short products are utilized, it is likely that governments will earn more than sufficient revenue to cover the costs in the first years of the scheme. As the criteria will become more stringent over time these revenues will probably remain sufficient.

The policy advisors stress the potential of EPR generating funding for R&D and they are currently looking into what this may look like. Whether the revenues are really significant to allow investments in R&D depends on how the policy is set up and therefore unknown.

EPR could also support recyclers by subsidizing for instance if a certain portion is post-consumer high-value recycled. Recyclers of post-consumer recycled textiles can achieve a competitive advantage or at least a fair level playing field by receiving financial compensation for their efforts.

*Table 4-10. Key points to consider when designing Mandatory EPR*

<b>Mandatory Extended Producer Responsibility</b>	
<b>Criteria</b>	<b>Key points</b>
<b>Design</b>	<ul style="list-style-type: none"> <li>• Brands are lagging to move towards circular design, need for push</li> <li>• Eliminate the fee for garments that use materials that are easy to recycle: mono-fibers (cotton and wool), biodegradable dyes and buttons.</li> <li>• Provide significant discount when recycled textile fibers are used that make the declaration of the products worth it.</li> </ul>
<b>Collection</b>	<ul style="list-style-type: none"> <li>• Brands do not receive enough mass, so an important part is to educate consumers on the importance to bring back their clothes to designated collection areas: in-store, municipality bins and charity</li> <li>• Improve consumer convenience</li> <li>• Incentivize proper disposal of the garments (e.g. reuse and high-value recycling) rather than number of clothes collected</li> </ul>
<b>Use of recycled textiles</b>	<ul style="list-style-type: none"> <li>• 15% recycled content, increase over time according to feasibility (market developments)</li> </ul>
<b>Monitoring and control</b>	<ul style="list-style-type: none"> <li>• Seek feasibility to ensure whether recycled textiles are post-consumer or post-industrial</li> <li>• Consider the quality and durability of the products made</li> </ul>
<b>Revenues</b>	<ul style="list-style-type: none"> <li>• Governments are likely to earn sufficient revenue from this scheme to cover the costs</li> <li>• Offer discount on fees that not only cover the costs of declaring</li> </ul>

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the items and obtain third-party certifications, it should also create a financial benefit for companies moving towards circularity

- Spend revenues on educational campaigns and if possible on driving innovations and subsidizing recyclers
- 

### **4.3.2 Green or Circular public procurement**

Governments can use their purchasing power to promote circular or sustainable products. A focus on circular products has the potential to stimulate not only the percentage of recycled textiles in products, but also pay attention whether companies are working towards closed material loops across the supply chain and the environmental impacts across the supply chain. Companies that merely focus on recycled materials, should be incentivized to also change the way products are designed so that they can be recycled and look at how they can get back their products at end-of-life.

The fact that there are very few companies that are (mostly) circular, which limits the choice of the government, may be an issue at the beginning. An option could be to increase the stringency of the criteria over time, starting with mostly focusing on recycled materials and plan additional criteria each couple of years to push market developments. Another option is to first only use GPP and when vital technologies develop implement CPP. The problem with this however is that it doesn't incentivize true circularity to brands: closed loop systems.

#### **Market**

Home goods seem an excellent market now for recycled cotton and wool, and thus CPP could incentivize the more circular systems. As part of the criteria the products could all be bought or leased under a certain contract, confirming that the products will return to the producer at end-of-life for proper processing. Same counts for workwear as presented in the example of the Netherlands implementing GPP. The problem of mechanically recycled cotton and wool having a rougher hand feel and texture, is less of an issue with home goods and workwear.

#### **Use of recycled textiles**

Through their purchasing power, public authorities can increase the demand for recycled textiles and potentially enable economies of scale. It is important that there is a sufficient supply of recycled textiles. Recyclers explained that the supply of textile waste is not a problem, rather the sorting process. Is there enough post-consumer textile waste per fiber type and color to supply (large) public procurement projects?

To set a minimum level of recycled content per product, results from this study can be used as baseline for further research. Based on the results of this study, a minimum level could be set at 30% recycled content per item. While 20% is may be feasible for a larger number of companies, a higher percentage may drive innovations.

Table 4-11. Key points to consider when designing CPP

Circular Public Procurement	
Criteria	Key points
<b>Design</b>	<ul style="list-style-type: none"> <li>• Favor products designed to be recycled or contain recycled materials</li> <li>• Favor products with a low environmental impact (such as, chemicals used, expected durability,</li> <li>• Quality and durability are also important criteria</li> </ul>
<b>Collection</b>	<ul style="list-style-type: none"> <li>• Purchase or lease product under contracts ensuring the return of the product to the producer at end-of-life, for proper processing</li> </ul>
<b>Use of recycled textiles</b>	<ul style="list-style-type: none"> <li>• Favor products with higher content percentage, aim for a minimum of 30% recycled textiles (excl. recycled PET bottles)</li> </ul>
<b>Monitoring and control</b>	<ul style="list-style-type: none"> <li>• Prioritize circular criteria as one of the key criteria next to price and durability</li> </ul>

### 4.3.3 Consumer Information on Reuse and Recycling

Several fashion brands indicated that the low collection rates are mainly due to the lack of knowledge among consumers about opportunities of reuse and recycling. The brands stated consumers often don't know that garments showing wear and tear are recyclable and often thrown away in the mixed waste. When consumers know about the opportunities of textile recycling and their role in the system, it is expected that consumers will also increasingly bring back the garments at end-of-life.

In order to reach different target groups, the information need to be provided in various ways. This policy is in particularly interesting if it is implemented in combination with other policy measures. However, it is important to consider that it usually takes time to change consumer behavior. The level of effectiveness is probably mostly based way of execution. Consumers can play an important role when they shift their purchasing power to products that are more circular. Holding campaigns that explain the need for consumers to purchase clothes that will last a long time, extend the product life through repair and reuse when possible and eventually dispose properly.

If the EU really wants to move to Circular Economy providing information regarding reuse and recycling seems vital to increase collection rates. It could even consist of large campaigns promoting all industries where reuse and recycling is applicable, resulting in increased awareness regarding general reuse and recycling.

Table 4-12. Key points to consider when designing consumer information campaigns

Consumer Information	
Criteria	Key points
<b>Main topics</b>	<ul style="list-style-type: none"> <li>• Importance of returning products when we don't use them anymore, potential for reuse and recycling</li> <li>• Where to return</li> <li>• Purchasing power to create positive change, prioritize high-quality clothes and repair en reuse</li> </ul>
<b>Target groups</b>	<ul style="list-style-type: none"> <li>• Entire population, thus need for different ways to reach different target groups</li> </ul>

#### **4.3.4 Material exchange platform**

In order to connect all players in the textile recycling industry, there is a need for a material exchange platform where companies can trade their recycled textiles. A platform could increase both supply and demand as materials become easier available. However, most interviewees explained that there is currently no transparency and trust in the textile industry which makes it very challenging to make this system functioning. For the platform to work it is vital that quality of the traded materials can be assured, for instance through certification of a third-party. However, companies are unwilling to provide information on the price and quantity of the materials, to remain in charge of the price. While the barriers form obstacles for the successful implementation of this instrument, a material exchange platform could be a key enabler in increasing textile recycling.

##### ***Transparency***

Circle Economy has set up such a platform, but also faces challenges in the execution due to the lack of transparency in the market. Therefore, policy makers can play an important role in the success of the material exchange platform. Potentially requirements on transparency of price and quantity can be set, but an agreement on European level is probably necessary as most of the post-industrial and post-consumer textile traders operate in different countries. Different interviewees state that they are mainly from Italy. Whether this is an option or not is out of scope of the research and knowledge of the author. The EU Action Plan for the Circular Economy however poses potential for increased regulation on waste trade. This may result in a decrease of the 'shady' trades, and create opportunities for other organizations.

##### ***Price***

When requiring this transparency about price and quantity, depending on the demand and supply, the traders may need to be protected and a minimum price could be set per kilo of fabrics. If the demand increases, the traders may even face greater profits, but since its unknown what the traders earn, this is difficult to know.

##### ***Quality***

To ensure the quality of the traded materials, third-party certification may be a solution. However, this adds costs and time for the traders. Besides, the interviewees mentioned multiple times that the post-industrial and post-consumer textile market can be a shady business, so the likeliness of these traders to obtain certifications is slim. If this platform does work, the shady traders are probably withdrawing from this business and the certification can be integrated in the process from the start of other companies which may lead to lower resistance. Research need to be done on how the quality can be ensured in a way that is feasible and affordable for both producers and governments.

##### ***Monitoring and control***

One of the benefits of this policy instrument is that an online market exchange platform allows tracking data and gain insights into the textile industry. The data obtained could give an clear overview of which materials are available and in which quantities, something that is currently unknown. This could result in increased efficiency and reaching economies of scale as recyclers potentially could have a fairly consistent supply of post-industrial or post-consumer textiles. Technologies such as Fibersort are probably vital in scanning the fabrics and providing trustworthy information on the contents of the textiles. However, for this to be trustworthy the technologies need to be proven to be accurate on large scale.

Table 4-13. Key points to consider when designing the Material Exchange Platform

Material Exchange Platform	
Criteria	Key points
Transparency	<ul style="list-style-type: none"> <li>Need for transparency of post-industrial/consumer fabrics regarding price and quantity, EU-level policy?</li> </ul>
Price	<ul style="list-style-type: none"> <li>Set minimum prize to protect traders</li> </ul>
Quality	<ul style="list-style-type: none"> <li>Ensure quality through affordable and feasible third-party certification</li> </ul>
Monitoring and control	<ul style="list-style-type: none"> <li>Online platforms provide data regarding: materials and quantities available.</li> </ul>

### 4.3.5 Requirements on customer convenience

While fashion brands try to make it as easy as possible for consumers to bring back their clothes at end-of-life. Brands still face major problems with not collecting enough mass through their take-back systems. In order to increase the collected items, most brands indicated that a combination of stakeholders should collect garments municipalities, collectors and brands themselves. Increased consumer convenience, such as increased proximity to the consumers, could increase the collected mass and reduce the percentage that ends up in mixed waste (Elander et al., 2017). However, consumers may ignore the collection bins if they are not aware of the need for recycling. Thus it is suggested that this policy is combined with increased consumer information.

The collector and policy advisors stated that collection bins in municipalities often contain more contaminated garments than other ways of collecting (through charity or brands) because consumers the garments as waste. While through other collection systems (charity and brands) consumers often donate or bring back clothes that are still in good shape. Thus also this is an important point to be included in informative campaigns to consumers. Since most clothes received by charities end up being sold abroad and downcycled, it may be an idea to partner with charity organizations and see how the destination of the post-consumer clothes can be streamlined with municipalities and increase the number of post-consumer clothes reused in a responsible way or recycled into new garments.

There are not specific demographic groups that should be targeted but rather all people, whether in rural areas or cities. The strategies however should be adjusted per target group. For instance, in cities the proximity is very important so many bins should become available. Whereas in rural areas people drive their cars more often for a longer time and maybe then convenience can be achieved by placing bins in supermarket stores. Same counts for age groups, young people may be best reached through social media while older people probably prefer to receive flyers through their mail slots.

Table 4-14. Key points to consider when designing the requirements on convenience

Requirements on customer convenience	
Criteria	Key points
Collection	<ul style="list-style-type: none"> <li>Combination of municipality bins, collectors and brands</li> <li>Partner with charities to streamline destination of collected post-consumer items</li> </ul>
Collection points	Mix of: <ul style="list-style-type: none"> <li>Brands in-store and shipping</li> </ul>

	<ul style="list-style-type: none"> <li>• Municipality bins</li> <li>• Charity</li> </ul>
<b>Target groups</b>	<ul style="list-style-type: none"> <li>• All people</li> <li>• Different strategies for:             <ul style="list-style-type: none"> <li>○ People in the city and in more rural areas</li> <li>○ Different age groups</li> </ul> </li> </ul>

### 4.3.6 Driving Research & Development

Policy makers can increase R&D through several instruments such as subsidizing or funding research institutes and pilot projects. Within the policy landscape around textile recycling (see literature review, section 2.7), there is one policy that could drive R&D: EPR. The policy advisors explain that the revenue generated from the scheme can be used for different purposes including financing research. Whether there is room for investments in R&D depends on the amount of revenue generated, and the costs of the implementation of the scheme. For instance, in the case of France, see section 2.8.1, the revenues were used to cover the costs of implementation, mainly subsidizing sorting facilities and campaigns for consumer awareness (Bukhari et al., 2018).

As part of the EU Circular Action Plan the EU is investing in R&D through subsidizing entrepreneurs and start-ups that have innovative solutions for problems we face along the entire value chain, from production to end-of-life management.

*Table 4-15. Key points to consider regarding research & development*

Driving Research & Development	
Criteria	Key points
<b>Type</b>	<ul style="list-style-type: none"> <li>• Providing subsidies or funding</li> <li>• Use revenues of other schemes to invest in R&amp;D</li> </ul>



## 5 Discussion

The findings are presented and analyzed in the previous chapter (Chapter 4). The aim of this section to discuss the findings and answer the two posed research questions:

- **RQ1: How can fashion brands increase the use of recycled post-consumer textiles through adjusting their business models?**
- **RQ2: Which policies are needed to increase textile recycling and the use of recycled post-consumer textiles?**

### 5.1 Proposition of business model adjustments

Based on literature and the results of this research, a CBMC is developed to guide fashion brands to adjust their business models in a way that increases textile recycling. The framework from Lewandowski (2016) is used to allow transferability of the adjustments to the business models of fashion brands, as it is based on the most commonly used BMC from Oswalder & Pigneur (2010).

The results show that brands should particularly pay attention to:

- Design garments that are durable and can be recycled (in the near future)
- Take-back clothes once consumers do not longer want to use them
- Partner with collectors, recyclers and mills to high-value recycle these clothes
- Increase focus on post-consumer textiles rather than post-industrial textiles

Therefore, the proposed CBMC focuses on these matters, see Figure 5-1. The CBMC is further elaborated in Appendix A.

Key partners	Key activities	Value proposition	Customer relationships	Customer segments
<ul style="list-style-type: none"> <li>• Create relationships with yarn suppliers directly</li> <li>• Collaborate with collectors (incl. municipality, retailers and charity)</li> <li>• Partner with research and development organizations</li> </ul>	<ul style="list-style-type: none"> <li>• Focus on creating recyclable garments</li> </ul>	<ul style="list-style-type: none"> <li>• Beautiful long-lasting or recyclable garments</li> <li>• Portion of garments contain <math>\geq 20\%</math> recycled post-consumer textiles in:                             <ul style="list-style-type: none"> <li>• jeans, sweaters, socks, home-goods</li> </ul> </li> <li>• Incentive to bring back</li> <li>• Reuse garments for reduced price</li> </ul>	<ul style="list-style-type: none"> <li>• Increased consumer engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Higher-end (conscious)</li> <li>• Lower-end, fast-fashion</li> </ul>
	<p><b>Key resources</b></p> <ul style="list-style-type: none"> <li>• Natural and sustainable fibers</li> <li>• Mono-fibers/fabrics</li> <li>• Recycled post-consumer textiles</li> <li>• Biodegradable dyes, buttons etc.</li> </ul>			
<p><b>Cost structure</b></p> <ul style="list-style-type: none"> <li>• Costs of take-back system (if not partnered with collector)</li> <li>• Resale has the opportunity for additional revenue</li> <li>• High value recycling more cost effective than downcycling or incineration</li> </ul>		<p><b>Revenue streams</b></p> <ul style="list-style-type: none"> <li>• No direct revenue stream has been identified yet</li> <li>• Resale has the opportunity for additional revenue</li> </ul>		
<p><b>Adoption factors</b></p> <ul style="list-style-type: none"> <li>• Train designers for developing recyclable clothes</li> <li>• Educate consumers on reuse and recycle</li> <li>• Drive R&amp;D</li> <li>• Prepare for future regulations</li> </ul>				

Figure 5-1. CBMC developed in this research to increase recycled textiles

Source: Own work, adopted from 'Designing the Business Models for Circular Economy – Towards the conceptual Framework' (Lewandowski, 2015)

#### 5.1.1 Key success factors

In order for a business model to be successful, the company has to ensure a 'fit' between the different building blocks (Lewandowski, 2016; Osterwalder & Pigneur, 2010). The key success factors for circular business models are discussed below and visually represented in Figure 5-2.

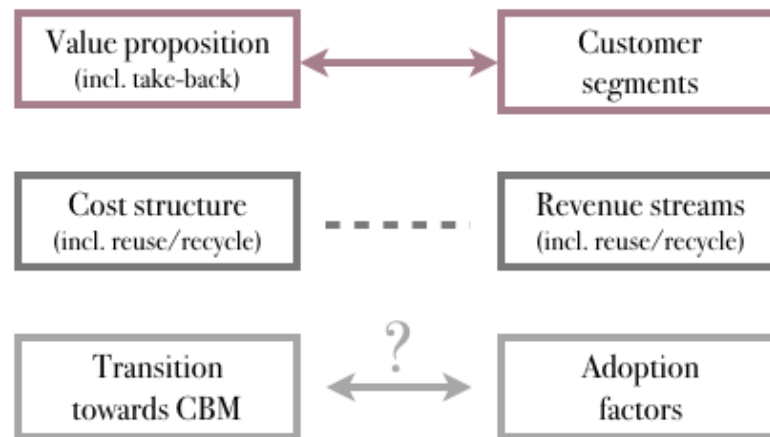


Figure 5-2. Visual representation of the key success factors of the CBMC

Source : Own work, adopted from *Designing Business Models for a Circular Economy – Towards the*

### **Value proposition – customer segments**

The results show that there is a fit between value proposition and customer segments when applying the CBMC. Brands experience increased customer engagement through services such as take-back management and repair, even through solely providing information on care and repair of garments online. The brands also state that sales increase are expected to be related to the sustainability efforts and some brands stated that the sustainable collection sold best. Based on the results, garments containing recycled textiles can be beautiful, of high-quality, and long-lasting when the right blend is found. Currently this is between 15-30% for recycled cotton jeans, for sweaters this is 40% recycled cotton and 70% recycled wool. Future innovations that the stakeholders to be economically viable in the next five years offer the potential to increase the number of materials that can be recycled and the percentages of recycled content.

### **Costs – revenue streams**

In contrast, there is a clear miss match between the cost structure and the revenue streams (Figure 5-2), however the degree is debatable. Thusfar, no direct revenue streams have been identified when increasing the use of recycled textiles, taking-back clothes and design for recyclability. However, as mentioned previously, a few brands in this study do state that being more sustainable does increase sales. Also, the costs for the take-back system are in some cases seen as marketing costs and is expected to have led to increased consumer engagement. The fact that high-value recycling is stated to be cheaper than downcycling or incineration processes has no effect on brands currently, as they are not responsible for their produced garments at the end-of-life. Garments that are made to last long have the potential to for resale if customers bring the items back when they don't wear it anymore. Ideally, these garments contain a portion of recycled when suitable.

However, the adjustments to the business model also helps brands move away from increasingly scarce resources which causes price fluctuations, such as the recent tripling prices for wool as one brand shared. Besides, if policy instruments do in some way extend the producer responsibility or increase the price of virgin materials, this business model would become economically favorable.

### **Transition to CBM – adoption factors**

Whether there is a fit between transition towards CBM and the adoption factors, the final key success factor, depends on how internal- and external environments develop. For instance regarding internal factors: when trained, do designers want to design for recyclability which currently limits them? External factors bring several risks and opportunities along. Brands operating in the EU risk that policies are implemented in the near future due to the EU Circular Economy Action Plan (European Commission, 2018a). Whether upcoming policies pose a problem for the brands depends on the policy's focus and the action of the brands. However, extending the producer responsibility appears to gain increased popularity by governments (Sociaal-Economische Raad, 2018), which would create an opportunity for brands that collect textile waste and use recycled textiles in the production of new clothes.

Another risk is the expected rise in prices of virgin fibers, creating a potential competitive advantage for recycled fibers. Besides, the extend to which the consumers will be educated in the future can also have effect on companies. If the assumption of the brands is true regarding the fact that increased consumer education and awareness would increase collection rates and the demand for garments containing recycled materials. There would be an opportunity for fashion brands offering these products and services. If regardless education and increased awareness consumers continue to purchase unsustainable clothes and keep throwing garments away in the household waste, the business model may not be successful without any policy instruments implemented.

### **Conclusion**

In conclusion, while revenue streams are not yet identified, results show that using recycled textiles doesn't have to cost more money than using organic cotton. For higher-end brands this may be less of an issue than lower-end or fast-fashion brands. Increased consumer engagement and recorded increased sales of sustainable collections show there is a fit between the brands' value offering and its targeted customers. The fit of the last key success factor is uncertain. In order to find out whether this business model is successful it is necessary to either conduct further research (i.e. confirm with stakeholders) or real-life testing.

## **5.2 Proposition for policy package**

In line with the work by Elander et al. (2017) it was found that mandatory EPR has the potential to create the greatest positive impact if designed and enforced well. The results of this study show that the identified policy interventions can address all of the prominent challenges that are not only related to lack of technologies (Table 4-9). The two policies that address the most challenges are: Mandatory EPR and CPP.

While front-running brands are taking steps themselves or through initiatives such as the voluntary GFA commitments, it is questionable whether this change has the desired impact, is fast enough, and will drive industry-wide changes instead of only the sustainability leaders. In order to transition the industry to a circular clothing system, the results of this study show that it would be beneficial for front-running brands if certain policy instruments are implemented to level the playing field for brands using recycled textiles and increase collection rates. The brands in this study seriously struggle to design recyclable clothes, this is mainly due to lack of technology. But since innovations are expected to arise soon policy instruments could push the industry once more options are available, ensuring a swift transformation to changing to recyclable designs. Once brands increasingly design clothes that can be recycled and collect these clothes at the end-of-life, the increase in textile recycling potentially moves from niche to mainstream.

## **5.2.1 Considerations**

Based on the results of Elander et al. (2017) and confirmed by this research, the author discusses the policies and proposes a policy package. Key considerations when designing the policy interventions are presented in the findings (section 4.3), the following sections discuss which policy package is preferable.

### ***Mandatory EPR***

Mandatory EPR is the only policy (in this study) that incentivizes a change in design, drive collection and the use of recycled textiles (Table 4-9). Besides the scheme provides financial benefits for producers of textile products that move towards circularity across the supply chain. It is expected that Mandatory EPR will have the largest impact on the increase in the use of recycled textiles, drive collection rates and incentivize circular design.

The implementation of EPR in multiple countries can stimulate textile recycling throughout Europe, as it is likely that companies make the same products for all markets for efficiency reasons and to achieve economies of scale. Thus, more stringent policies in a number of countries in NWE has the potential to change the industry.

The design and enforcement of Mandatory EPR however, is also the most complicated. Likely third-party certification will play a significant role which can be costly and time consuming. But several aspects need further research, such as: How can we assess whether products are made to last-long? How can we incentivize companies to extend the utilization periods of their products? At what price should the fee be set in order to encourage the industry and create competitive advantage for the brands that use recycled textiles and produce recyclable products?

### ***Information and convenience***

Based on the findings, the author believes that vital to the success of the EPR schemes, consumers need to be well informed about reuse and recycling and the customer convenience need to improve. While, changing consumer behavior takes time, consumers are becoming more aware of the issues in the fashion industry through the media which has resulted in a new consumers segment: conscious consumers. Making consumers aware of the current situation and their role in the system, is expected (by industry stakeholders) to increase the number of clothes collected as well as demand more recyclable products or with recycled content.

### ***CPP***

Due to the fact that home textiles and workwear are an excellent market for recycled and recyclable textiles at the moment, it is suggested that governments use their purchasing power to favor circular products. Besides, implementing CPP does not require many resources and efforts.

However, it is of lower priority since the impact is also lower as it does not really target consumer fashion brands. While it can drive the home textiles and workwear markets, the purchasing power of the public authorities are not likely to drive fashionbrands.

### ***Material Exchange Platform***

There is a strong need for a transparent post-consumer textiles market and in theory the material exchange platform provides the perfect solution. In reality however, a successful platform seems unfeasible at the moment because of the shady trading market. To make the platform work, steps have to made to improve transparency. Probably resulting in monitoring

all trades to ensure legitimacy, quality and fair trade. Since most of these trades happen across nations, increased regulation on EU-level seems required to the success of such a platform. Once the transparency is improved, a material exchange platform is strongly recommended.

### Conclusion

The diagram from Figure 2-8 is updated based on the findings from this study and discussion above, see Figure 5-3. All of these policies are of priority and therefore marked in grey. Mandatory EPR remains of highest priority and proven by France to be feasible. However several aspects need to be researched further (stated previously) and the design of the policy should advance from the example of France. CPP is anticipated to be certainly feasible, but the impact on fashion brands is much lower than EPR. A material exchange platform seems currently unfeasible, unless regulations on transparency are implemented on EU-level. Customer convenience and consumer information are expected by the stakeholders to play a vital role and should be closely tied to Mandatory EPR to ensure its desired impact. While feasible, the level of impact is uncertain as changing consumer behavior takes time. Besides, no issues regarding feasibility have been identified regarding customer convenience and consumer information.

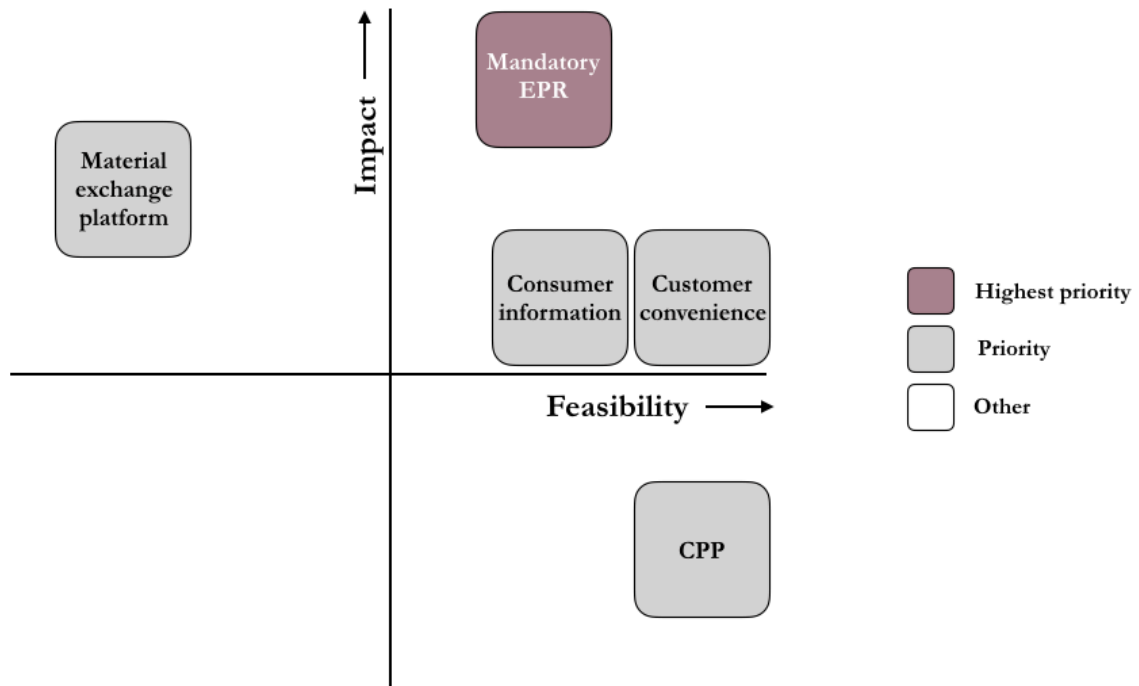


Figure 5-3. Visual representation of expected impact and feasibility of the selected policies based on this study

Source : Own work.

This research recommends the European Commission and governments in NWE to implement the policy package consisting of: Mandatory EPR, improving customer convenience regarding collection points and consumer information on reuse and recycling. More information on the key points to consider when designing the policy package can be found in sections 4.3.1, 4.3.3, and 4.3.5.

The policy instrument Circular Public Procurement is also suggested, as its markets are a good fit for products containing recycled textile fibers. However due to its lower impact on fashion

brands the policy instrument is not included in the main recommendation. Additional information can be found in section 4.3.2.

### 5.3 Potential impact of policy package on CBMC

Brands that are moving towards circularity by increasing the use of recycled textiles, take-back their clothes, and changing the way their garments are designed to allow recyclability, potentially obtain multiple benefits if the policy package is implemented.

#### 5.3.1 Level playing field

First of all, and probably the most important, a fair level playing field is created by financially incentivizing front-running brands. The higher costs of recycled or recyclable materials will be compensated by discounts provided through EPR, while virgin materials are becoming more expensive through the fee (Elander et al., 2017). Whether the brands that do remain so-called 'linear' find this fair is unlikely, but may trigger them to change to more circular systems.

#### 5.3.2 Increased consumer awareness

Both brands and governments could increase consumer awareness regarding reuse and recycling. An increased understanding of the current situation and textile waste issue could lead to marketing and sales opportunities, competitive advantage and increasing consumer engagement.

For instance, when the general awareness among consumers increases regarding the importance of long-lasting clothing, recyclability and recycled materials. Brands can then promote the fact that some of their garments are completely recyclable and yet long-lasting. This creates the opportunity to connect with consumers and asks them to return their garments after they stop wearing the items. As consumers understand the importance, due to increased awareness, garments are brought back when not longer worn. Once sufficient garments are collected, the batch could be high-value recycled and used into new garments, which also could be used in marketing.

The time between the purchase and returning the garments, however, is uncertain but may take years. Especially if the garment designed to last-long. This strategy may be suitable for fast-fashion companies if prices can be kept similar. It is important to note that while an increased consumer awareness has the potential to change buying behavior, it takes time and has proved to be show small effects on purchase decisions (Elander et al., 2017). However, the consumers of the brands in this study are often conscious consumers and, according to brands, do respond to marketing related sustainability efforts. Increasing consumer awareness could raise the number of conscious consumers.

#### 5.3.3 Increased collection rates

When brands are responsible for processing their garments at the end-of-life and simultaneously consumers are better informed about the importance of bringing back their clothes (through campaigns by government and brands), it is expected that the collection rates will increase (Elander et al., 2017).

Higher collection rates are vital for the circular clothing system to function successfully. Automated sorting technologies will become more important as more mass is collected and need to be processed accordingly. Technologies such as Fibersort can speed up the recycling process and, hopefully, increase the accuracy of the sorted batches. These batches can then be processed on a larger scale with potentially an improved reliability of the recycled output.

### **5.3.4 Textile recycling**

The findings in this research show that it is feasible for brands to create products containing recycled cotton and wool. This doesn't take away the complexity of finding the right blends for desired quality, performance and handfeel. Despite the fact that the brands in this study were able to incorporate recycled materials, it is not certain whether this is the case for other brands. While EPR can drive the uptake of recycled textiles, it is vital that the supply chain can handle the increased number of textiles that need to be processed into high-value recycled fibers and in turn into garments. Because when brands are charged a substantial fee for each item they put on the market that does not contain recycled or recyclable materials, it needs to be ensured that it is actually possible to use these materials on scale.

Regarding ambitions targets, they may drive textile recycling but could lead to discouraged brands and unfair competition (Elander et al., 2017). This is especially relevant for policies such as EPR, however, setting relatively high percentages of recycled textiles as a criteria for GPP or CPP, could push the market and technological innovations.

Paying special attention to the recycled material is key as synthetic fibers, such as polyester made from recycled PET bottles, release micro-fibers that contaminate our oceans (Ellen MacArthur Foundation, 2017). Also, the use of chemicals in dyeing and treating processes should be considered and restricted, as a part of the circular economy concept is to design out harmful materials (Ellen MacArthur Foundation, 2017).

## **5.4 Summary of contributions to research**

This research confirms that the challenges to increase recycled textiles are in line with the work by Watson et al. 2017, and also apply to sustainable brands of a larger geographical scope. Additional key challenges found in this study are the low collection rates among brands that have a take-back system in place and shipping waste across borders. Besides, this research enabled to find patterns based on the customer segment and company size in combination with the key strategies and recycled materials. For instance, the results show that the 'large' fashion brands in this study use post-industrial recycled textiles, while 'small' and 'extra-large' currently use post-industrial recycled textiles.

Results show that special attention has to be paid to design for recyclability, in both policies as business models. Change in design is key to moving towards a circular clothing system and at the moment this is seriously lagging behind. Technology is one of the main obstacles for the lack of recyclable materials options, but it is expected by the stakeholders to arise within five years and may enable recycling some of our current clothes.

Additionally, the need for a focus on post-consumer recycled textiles has become apparent, since recyclers indicate that nearly 95% of the recycled textiles are post-industrial at the moment. The major obstacle is not knowing what materials the clothes are made of. When brands collect their own clothes this issue could become a recycling opportunity as they know what they did put into the clothes. But still most clothes are not designed to be recyclable or have been collected already. Future recycling innovations have the potential to recycle the currently collected items.

Findings show that a push is needed to drive textile recycling, and a combination of the selected policies show to have the potential to overcome the current challenges. This research not only looked at mandatory EPR and GPP such as most sources, but took the findings of Elander et al. (2017) as a foundation and explored the combination of policies best suitable for the current textile recycling market, and fashion brands in particular.

## 5.5 Summary of contributions to practice

By providing an structured overview of the challenges and opportunities brands, recyclers and a collector/sorter face implementing the three key strategies, this report could be useful to brands wanting to move towards circularity and anyone wanting an improved understanding of the post-consumer textile recycling market. The proposed CBMC based on the results of this study could be used as guide by brands that want to increase the use of post-consumer recycled textiles.

The overview of challenges combined with an enhanced understanding can help policy makers be more informed about policy decisions. For instance, this study presents a clear overview of which materials and how much recycled content is used by front-running brands at the moment. This could be helpful for setting policy criteria such as minimum on recycled post-consumer content percentages for the materials identified (cotton and wool). Additionally, it could inform brands that do not yet use recycled textiles, design for recyclability or have a take-back system in place about the current situation and what is feasible and what challenges the strategies bring.

The fact that this research confirms that one of the major issues is that the unknown content of the collected textiles confirms the need for and importance of the Fibersort technology and similar or other upcoming sorting technologies. Implementing the proposed policy package or CBMC could also contribute to a decrease in textile waste and an increase in textile sorting and recycling, and an increased use of post-consumer recycled textiles.

## 5.6 Limitations and future work

The proposed CBMC or policy package are not yet tested and therefore the impact is not certain. Besides, the author used the BMC as framework to enhance the transferability of the business model across many brands, however the extend to which the proposed CBMC is feasible for different brands is uncertain. For instance, brands indicate that some implemented strategies had resulted in greater customer engagement and probably are related to the increase in sales. But this may not be the case for brands that do not have consumers that value sustainability or circularity efforts. Moreover, is there a business case for the proposed CBMC or is it merely going to increase costs. This also depends whether upcoming policies are going to increase the price for virgin materials and provide benefits for purchasing recycled materials.

Due to the fact that the brands in this study did not have the Product-as-a-Service strategy implemented yet, this research has not been able to provide insights and recommendations regarding service models. Opportunities related to recycling and leasing should be studied by exploring companies that currently (try to) create value through leasing their clothes (i.e. MUD Jeans). Besides it could be favorable to establish which materials can be recycled in the near future so that brands are less limited in designing clothes for recyclability.

While mandatory EPR has the potential to create a large impact, in order to enforce the policy effectively some questions need to be answered, such as are there viable certification systems that can verify materials and whether a piece is post-industrial or post-consumer, and how to promote extending the utilization periods? Moreover, increasing consumer awareness on the importance of reuse and recycling may not result in changes in consumer behavior (in for example increased: sales, collection rates, utilization periods). According to the results of this study, the Material Exchange Platform is currently unfeasible, but more in-depth studies focused on this policy instrument are suggested to see if it could be feasible in some way due to the need for such a platform.



## 6 Conclusions

This research proposed two variations of an adjusted business model, for higher-end fashion brands and lower-end (fast-) fashion brands, as well as a policy package that will drive the use of recycled textiles.

To answer the first research question: **How can fashion brands increase the use of recycled post-consumer textiles through adjusting their business models?** The author proposes that higher-end fashion brands create value through offering beautiful garments that last-long and offer services to increase the utilization period. Whereas lower-end fashion brands can start with creating at least one collection or certain type of garments (e.g. jeans) made from recycled or recyclable materials. Products such as jeans, sweaters, socks and homegoods made from cotton, wool or cashmere should contain at least 20% recycled post-consumer textiles, preferably higher for products containing wool and cashmere. Regardless the consumer segments, brands should set up a take-back system provide in-store collection points and national shipping options. Financially incentivizing consumers through vouchers of \$5 or 10% on the next purchase has shown not to be effective, as most brands expressed not to receive enough mass. Brands are encouraged to seek for alternative incentives. Besides, all brands should provide information to consumers on the importance to bring back their clothes.

The focus of key resources and activities shifts to prioritizing the design of garments that contain post-consumer recycled textile fibers and/or are recyclable. Results from this study show that most front-running brands achieved to make sweaters made from 70% recycled wool and 40% recycled cotton, and jeans between 15-30% recycled cotton. From the seven brands in this study that use recycled materials, four brands use post-consumer recycled cotton and wool, whereas three brands use post-industrial recycled: cotton, wool, and cashmere. Only one brand designs clothes with recyclability in mind. Consequently, there is a need for an extra focus on circular design and the use of recycled materials made from post-consumer textiles, and therefore part of the suggested adjustments to business models.

The brands should move to partnerships with the yarn mills directly (rather than clothing manufacturers), which is expected to speed up the transition to the use of recycled textiles. Additionally, collaborations should be sought with collectors to seek for efficient and effective processes where most of the garments are actually re-sold by brands or the items made from cotton, wool and cashmere high-value recycled into new garments. Brands could also decide to take back their clothes in-store and through national shipping options, since it enhances the likelihood of actually receiving recyclable mass. Taking back the clothes and becoming involved in the end-of-life management may also increase awareness of the brands and a change in the way the garments are made.

Multiple brands have experienced increased consumer engagement and sales through offering sustainable products and services such as: take-back and repair services. However, no additional revenue streams have been identified, while the costs of recycled or (organic) natural fibers (which can be recycled) are often more expensive (usually 10-20% markup).

All brands should prepare for internal and external factors that can influence the success of the business model. The brands are suggested to train all designers to design products according to the circular economy principles, and in particular to be recyclable. Besides, brands should educate employees and consumers about their role in the circular clothing system, aim to drive R&D and prepare for upcoming policies.

Answering the second research question: **Which policies are needed to increase textile recycling and the use of recycled post-consumer textiles?** The author recommends the policy package as it addresses most of the key challenges front-running fashion brands are currently facing. The policy package consists of: Mandatory EPR, increasing consumer information regarding reuse and recycling, and improved customer convenience to garment collection points.

Mandatory EPR can drive the currently lagging design for recyclability, low collection rates and increase the use of post-consumer recycled materials by fashion brands. Through Mandatory EPR all garments placed on the market are charged by a fixed fee, usually different per weight and product category. The garments can be recycled, are made from recycled materials, and/or are collected at the end-of-life, receive a substantial discount creating a level playing field for brands using recycled or recyclable materials. Products are likely to be assessed by third-party certification that can verify the material content or source. The criteria for use of recycled textiles could start with garments receiving a discount for products containing 15% recycled textile fibers. This percentage should increase over time according to technological developments. If possible the quality and durability of the products should also be taken into account.

Due to the low collection and clothing utilization rates, EPR should be implemented simultaneously with increasing awareness among consumers on importance of reuse and recycling. The information should stimulate consumers to: wear their clothes longer, take better care of them, and bring their clothes back after use so they can be reused or recycled into new clothes again. Without increased consumer awareness, Mandatory EPR may not be able to succeed, as an important part of the scheme is to increase the mass collected to support the increase of reuse and recycling. Besides, brands and other stakeholders explained that customer convenience is important and we need to seek for creative ways to incentivize consumers (preferably non financial) to bring back their clothes to collection points.

Developing Mandatory EPR may be very resource intensive (time, develop monitoring systems and finding suitable certification schemes), but if designed well governments will create revenue with this scheme that cover the costs. The revenue is expected to exceed the costs and can be used for informative campaigns and support R&D.

CPP is included in the recommendations due to the excellent fit with the current recycled textiles market. The reason CPP is not part of the first policy package is because it does not directly target fashion brands which was the focus of this research, but rather other textile product manufacturers (such as from furniture or workwear) but still relevant when answering the second research question. Public authorities should prioritize to purchase their office furniture containing textiles and workwear made from recycled cotton and wool. Their purchasing power can be used to drive ambitious percentages such as >30%, while considering the importance of durability. The products should be bought or leased under a contract that ensures products reaching their end-of-life, are returned to the producer for proper disposal (preferably reuse and high-value recycling). Depending on the level of complication the government is willing to accept, a distinguishment in criteria can be made between the minimum recycled content level of wool set at 70% and cotton at 30%.

### **Futher research**

The author recognizes that the research poses limitations, addressed in section 1.7. While the results provide a solid basis, it is suggested that additional aspects are studied in order to increase reliability. The author proposes that further research should be carried out in the areas listed below:

- Business model experimentation of proposed adjustments to fashion brands' business model to increase reliability of success.
- Explore to what extent brands can design for recyclability or circularity: whether its feasible for large scale productions, can brands remain unique and what are the additional costs.
- Research the experiences of front-running brands that are offering Product-as-a-Service, and which policies could stimulate these business models.
- Strong need for additional research on policy assessments from policies relating to high-value textile recycling.
- Further research around the quality and durability of the products containing recycled content is necessary to move away from assumptions.
- Seek for third-party certification solutions that can verify material content and quality/durability, while staying affordable. Is distinguishment between post-consumer and post-industrial textiles possible?
- Assess how products eligible for receiving a discount in the EPR scheme can receive enough benefit that it is worth it to move to circular practices.
- Review how different consumer groups can be targeted to improve customer convenience and provide effective information on reuse and recycling.
- Research how the shady trades of post-industrial and post-consumer textiles can become transparent, enabling a market exchange platform.

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## Appendices

### A. Circular Business Model Canvas Explained

The sections below elaborate on the CBMC that is presented in Chapter 5. For easier reference purposes, the CBMC is copied on the next page (Figure A1).

#### A1. Customer segments

The brands in this study were either somewhat higher-end (bridge and affordable luxury) or lower-end (value). Therefore two different consumers segments are considered for the CBMC.

- Higher-end: Brands that fall under the fashion market segments bridge and affordable luxury, in which the price range of standard garments (such as tops and pants) usually varies between €95 - €315.
- Lower-end: Brands in market segments value, where the standard items often are prized between €20 - €40 (see Table 3-2).

While it is likely that the main consumers targeted are the sustainably conscious ones, nearly all brands indicate that sustainability is great for marketing and, while difficult to measure, they expect that offering sustainable products increased sales and consumer engagement. Thus potentially, the customer segment is broader than conscious consumers only. Anyone that is interested in the garments the brands offer can be targeted.

#### A2. Value proposition

##### **Higher-end segments**

For consumers from the higher-end segments, value is delivered to customers by creating beautiful garments that are made to last long a long time. Products such as jeans, sweaters, socks and homegoods made from cotton, wool or cashmere often contain a minimum of 20% recycled textiles. For some consumers, the fact that garments contain recycled textiles adds value to sustainably conscious consumers that want new clothes that create a positive impact.

When consumers do not want to wear their garments anymore, they are encouraged to take-back the clothes to the brand through a small financial incentive. Due to the reported physical and emotional durability of the products, additional consumers should be informed about the current situation in the textile industry and their role in the system. The high quality and long-lasting garments can often be resold, adding a revenue stream, to consumers in lower-end segments.

##### **Lower-end segments**

The low utilization rates of garments from fast-fashion consumers could be addressed by offering a portion of the products that are recyclable (or in the near future). However, lower priced garments are often made from synthetic materials as they are cheaper than the recyclable wool and cotton. Therefore, the lower-end brands could first focus on a collection or certain garment types. For instance, the brands could change the way all jeans are designed to make them recyclable by considering the material use, stitching and buttons, and the dyes used. When increasing the economies of scale, there is a potential of keeping the prices for these garments low. Value is created through offering consumers to a 'guilt-free' alternative.

Again, consumers are incentivized through a small financial incentive to bring back their clothes when they don't want to wear the items any longer. To stimulate the garment take-back, the financial should be paired with informing the consumers on the textile production, the waste issue and their role in the system. The collected items are sorted and when possible reused and/or high-value recycled.

<b>Key partners</b>	<b>Key activities</b>	<b>Value proposition</b>	<b>Customer relationships</b>	<b>Customer segments</b>
<ul style="list-style-type: none"> <li>• Create relationships with yarn suppliers directly</li> <li>• Collaborate with collectors (incl. municipality, retailers and charity)</li> <li>• Partner with research and development organizations</li> </ul>	<ul style="list-style-type: none"> <li>• Focus on creating recyclable garments</li> </ul>	<ul style="list-style-type: none"> <li>• Beautiful long-lasting or recyclable garments</li> <li>• Portion of garments contain <math>\geq 20\%</math> recycled post-consumer textiles in:                         <ul style="list-style-type: none"> <li>▪ jeans, sweaters, socks, home-goods</li> </ul> </li> <li>• Incentive to bring back</li> <li>• Reuse garments for reduced price</li> </ul>	<ul style="list-style-type: none"> <li>• Increased consumer engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Higher-end (conscious)</li> <li>• Lower-end, fast-fashion</li> </ul>
	<b>Key resources</b>		<b>Channels</b>	<b>Take-back management</b>
	<ul style="list-style-type: none"> <li>• Natural and sustainable fibers</li> <li>• Mono-fibers/fabrics</li> <li>• Recycled post-consumer textiles</li> <li>• Biodegradable dyes, buttons etc.</li> </ul>		<ul style="list-style-type: none"> <li>• Reverse logistics</li> <li>• Provide online assistance to care &amp; repair clothes</li> </ul>	<ul style="list-style-type: none"> <li>• In-store, own/all brands</li> <li>• Link take-back to relevant recyclers</li> </ul>
<b>Cost structure</b>		<b>Revenue streams</b>		
<ul style="list-style-type: none"> <li>• Costs of take-back system (if not partnered with collector)</li> <li>• Resale has the opportunity for additional revenue</li> <li>• High value recycling more cost effective than downcycling or incineration</li> </ul>		<ul style="list-style-type: none"> <li>• No direct revenue stream has been identified yet</li> <li>• Resale has the opportunity for additional revenue</li> </ul>		
<b>Adoption factors</b>				
<ul style="list-style-type: none"> <li>• Train designers for developing recyclable clothes</li> <li>• Educate consumers on reuse and recycle</li> </ul>		<ul style="list-style-type: none"> <li>• Drive R&amp;D</li> <li>• Prepare for future regulations</li> </ul>		

Figure A1. CBMC developed in this research to increase recycled textiles (copied from Chapter 5)  
 Source: Own work, adopted from 'Designing the Business Models for Circular Economy – Towards the conceptual Framework' (Lewandowski, 2015)

#### A4. Key resources

In this business model, the focus lies on using recycled textiles and creating products that can be recycled. Therefore, the emphasis should lie on using: natural and sustainable fibers, mono-fibers or mono-fabrics, recycled post-consumer textiles and biodegradable dyes and additives such as buttons. Compiling the efforts of the brands, each of the suggested key resources are feasible and used multiple times.

Feasible percentages of recycled content in garments for brands in this study are: sweaters from recycled wool 70%, jeans containing recycled cotton between 15-30%, and sweaters containing recycled cotton 40%.

#### A5. Key activities

To increase textile recycling, the brands activities should concentrate on designing products that last-long, are recyclable, and/or contain recycled content. While designing products that last-long is a more common practice, it is important to increasingly create products that are recyclable at the end-of-life. Current technologies however do limit the options, but focusing on creating products that are recyclable in the near future gives more possibilities.

#### A6. Key partnerships

Fashion brands should create partnerships with yarn suppliers directly, which according to one of the recyclers, could speed up the transition towards using recycled textiles in production.

To address the low collection rates, collaborations between other collectors (i.e. brands, municipalities, retailers and charities) could increase textile recycling by potentially solving the minimum order requirement problem.

Since the technologies for sorting and recycling are so limited and yet so vital for moving the use of recycled textiles from niche to mainstream, it could be beneficial to partner with research projects and organizations. Brands' input is vital in the development and commercialization of new technologies. Besides, when these technologies become available opportunities for the brands arise.

### **A7. Take-back system**

The take-back system can be set up in-store or offering national shipping options. Depending on their purpose, brands can choose to collect only their own brand or all brands. If brands aim to high-value recycle the collected items, it is suggested that only the own brand is collected so that the content of the garments is known. Brands that do not plan to reuse or recycle the collected garments can collect any brand.

### **A8. Customer relationships**

Several brand in this study mentioned to have experienced increased consumer engagement when offering services such as: take-back and repair services. Additionally, some brands stated that the sales of their more sustainable collection are higher than other collections, which can be due to the increased quality of the garments or the fact that they are sustainable (i.e. sustainable materials or garments that have a lower environmental impacts).

### **A9. Channels**

Channels to reverse logistics are added to make the take-back system possible. In addition, brands should guide consumers on care & repair in order to extend the product life, which has the opportunity to increase consumer engagement (as explained by some brands in this study).

### **A10. Revenue streams**

Higher-end brands experience an additional revenue stream through second-hand sales of their collected garments. Regarding recycled textiles, no direct revenue stream has been identified yet in literature and by brands interviewed in this study. However, as mentioned previously, brands in this study have suggested their expectation of increased sales due to sustainability efforts such as offering take-back and repair services as well as offering products made from sustainable materials or ethically produced.

### **A11. Cost structure**

When working together with an international collector, the take-back system adds no extra costs. Brands collecting the garments themselves do have additional costs of taking back clothes, however it is seen as a part of marketing.

Looking at the additional costs of using post-consumer textile fibers rather than virgin textile fibers, recycled cotton is priced similarly as organic cotton and polyester has around a 10-20% mark-up. This would indicate that brands using organic cotton can move to using recycled cotton when suitable. Besides, sustainable products often cost more thus the additional costs could be transferred on to the consumers. Keeping in mind that the sustainable collection of one brand, which is also slightly more expensive, still sells best.

Comparing the costs of handling the post-consumer textiles, it seems that the high-value recycling scenario is most cost-effective ( $\pm$  €0.10 - €0.20 per kg), downcycling is slightly more expensive ( $\pm$ €0.20 - €0.25 per kg), and incineration is the most costly (€0.30 - €0.35) (Circle Economy, 2015). If these price indications are correct, brands would benefit from designing products that can be recycled rather than incineration. However, brands are not the ones that currently pay the waste-management thus this will only have effect if the producers become responsible for the handling the garments at end-of-life.

## **A.12 Adoption factors**

To support the transition towards circular business models and increase textile recycling brands should consider to adoption factors: internal and external factors that could influence and stimulate the success of the business model.

Internal factors could consist of training all designers to design for recyclability and educating employees on why the new strategies are important and how they play a role in the system. External factors could include educating consumers, drive R&D and prepare for upcoming policies.

## B. Interview guides

Prior to each interview, CSR reports and websites were consulted. The interview guides were adjusted and extended based on the case-specific information found. For instance, brands communicate on their websites and CSR reports whether or not they have a take-back system in place. Thus questions are adjusted for each interview accordingly.

### Introduction and introductory questions

#### General:

1. Which fibers and/or blends does your brand use most? Top 5?
2. Can you rank these materials and blends from most used and down?

Material/blend	Rank

#### Use of recycled content:

3. I see in your CSR report/on you website that you use recycled materials, can you elaborate on this? How is it going?
4. Do you focus on post-consumer or post-industrial recycled textiles? Why?
5. What are the percentages of recycled content you use per fiber type?
6. How is the quality of the fabrics containing recycled content?
7. Do you use recycled content in specific garments? Or throughout the collections?
8. Where do you get your recycled content from?
9. Is there sufficient supply of recycled textiles?
10. What are (other) main challenges?
11. How do these products sell?
12. Do you know how much percentage the markup of recycled textile fibers is in general compared to virgin fibers?
13. I read that (name fashion brand) uses high quality materials. What about instead of the closed loop, use open loop recycling where other companies would buy your post-consumer garments, recycle and use in their production? Have you looked into this?
14. Customer feedback?

#### Circular design:

15. What about design for circularity? Are you looking at design phase how it becomes easier to handle the products at end-of-life? Why/why not?
  - Yes:
    - a. What do you do?
  - No:
    - b. Are you looking into it or is it not a priority?
16. You use sustainable materials, do you also pay attention to monofibers or monofabrics?
  - a. Can you elaborate on the quality and choice of mono fibers and fabrics?

17. Do you think it is feasible for fashion brands to incorporate garments in their collections that are recyclable? Can you explain why/why not?

**Take-back management:**

18. Do you have a take-back system in place, and why or why not?
- Yes:
    - a. Which partners do you work with?
    - b. Do you face any challenges?
    - c. Do you know what happens with the clothes at end-of-life?
    - d. Are you involved?
    - e. How is it going?
    - f. How and where is it sorted? Can you elaborate?
    - g. Do you collect garments from your own brand or all brands? Why?
    - h. What kind of incentive do you have in place (if any)?
  - No:
    - a. What are the barriers or considerations not to do so?
    - b. Which partners have you looked at?
    - c. Why not through a bigger organization such as I:Collect.
19. In order to implement a business model and increase textile recycling, in some way the clothes should be collected at the end-of-life.
- a. Do you currently collect your clothes? Or are you connected to an organization that handles your take-back of clothes? How is it organized?
    - i. Do you work with partners? Which ones?
    - ii. Do you know what happens to these collected clothes?
    - iii. If not: Do you see an opportunity that your clothes can be high-value recycled at end-of-life? Or downcycled?
  - b. What (other) options do you see for your brand?
  - c. Which barriers?
  - d. Do you see room for improvement? Or opportunities?
  - e. Partnerships?
  - f. Feedback of customers?
  - g. Do you monitor what clothes are collected? (e.g. in which quality and state)
20. And finally a more general question on if you have any ideas on how you think take-back management should/could be organized?
- a. By brands, municipalities, charities?
  - b. Any key considerations we have to pay attention to?

**Other questions (not brand specific and if time)**

21. What do you think about policy intervention? Is that something you look at and see there is a need for/talk about?
- a. In which ways do you think policies could increase the use of recycled textiles?
  - b. Are you aware of current policy options for the textile industry?
  - c. If yes:
22. In order to move to a circular economy all clothes should be collected at end-of-life, do you have an idea how that should look like?
23. Do you think brands should be responsible and do it themselves? Or through Municipalities and Charities? Combination of all? Or maybe collaborations?
24. Do you see opportunities for other kind of fashion brands to use recycled materials?

25. I found in literature that in the fashion industry there is a lack of transparency and trust which makes collaborations challenging. What is your take and experience on this?
  - a. How are the collaborations going? Do you see that other brands are willing to collaborate and share information or is it difficult?



### C. Circular Business Model Innovation Frameworks

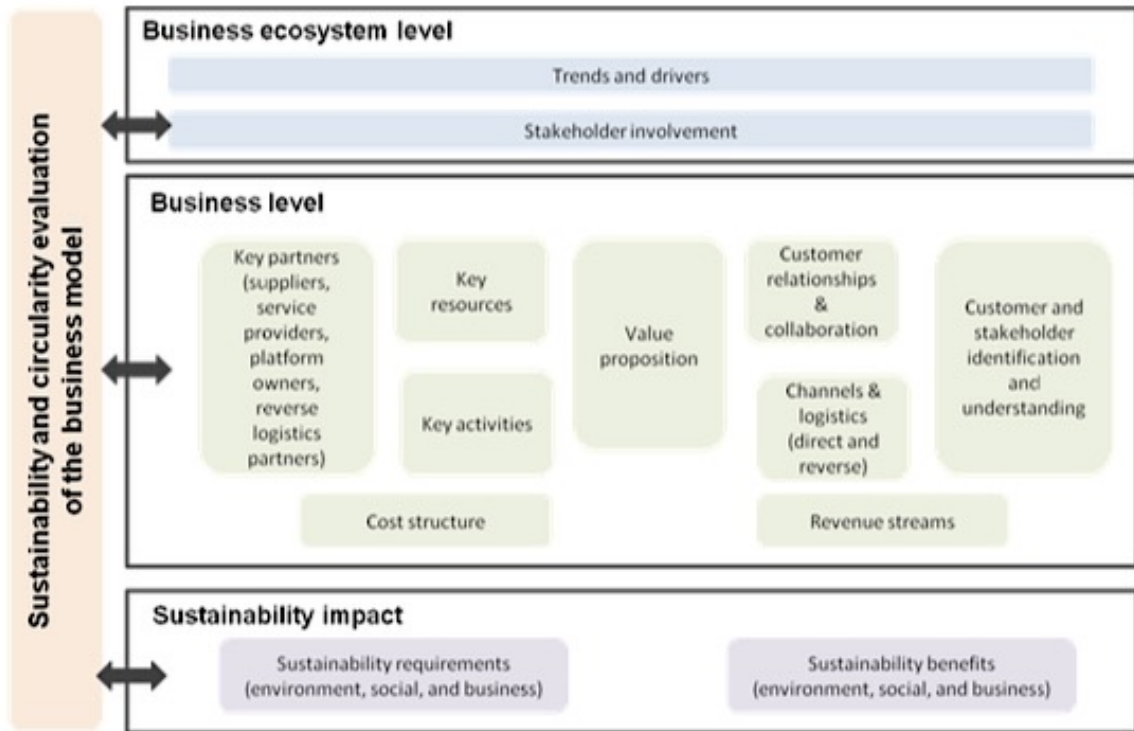


Figure C-1. Framework for sustainable circular business model innovation  
 Source : Derived from : ‘A Framework for Sustainable Circular Business Model Innovation’ by (Antikainen & Valkokari, 2016)

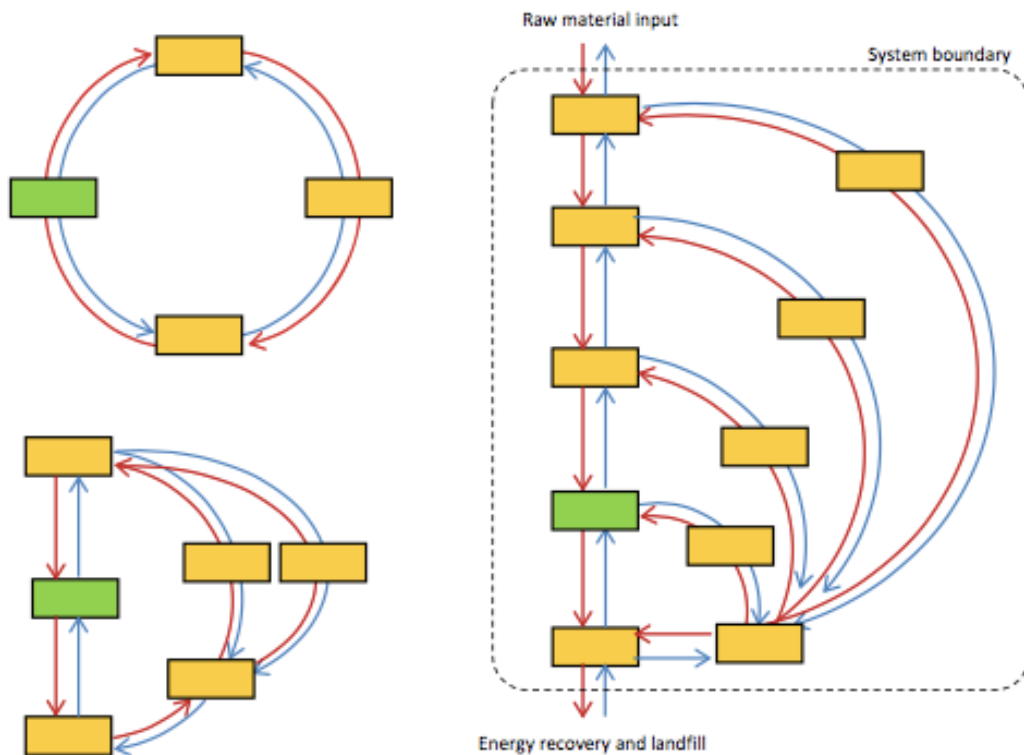


Figure C-2. Possible framework designs of the Business Cycle Canvas  
 Source: Derived from ‘Circular Business Model Innovation: A process framework and a tool for business model innovation in a circular economy’ (Mentink, 2014)

## D. Policies explained

Table D-1. Overview of opportunities and barriers of administrative policies stimulating textile recycling

Administrative policies				
<b>Requirements on customer convenience</b>	<p>One way to increase the amount of textiles collected is to make it more convenient for customers to return their end-of-life textiles, for instance by implementing requirements for municipalities to have collection points in certain proximity from the houses or mandating retailers to take-back clothes at end-of-life (Elander et al., 2017). The aim of this policy measure is to lower the proportion of textiles ending up in mixed municipal waste and increase the collection rates (Elander et al., 2017).</p> <p>Example: Increase proximity between collection points and consumers; require retailers to provide collection possibilities.</p>			
	<table border="1"> <thead> <tr> <th style="text-align: left;"><u>Opportunities</u></th> <th style="text-align: left;"><u>Barriers</u></th> </tr> </thead> <tbody> <tr> <td> <ul style="list-style-type: none"> <li>• Increase collection rates and supply of post-consumer textiles, while lowering proportion of textiles in mixed waste</li> <li>• Improves convenience for consumers</li> </ul> </td> <td> <ul style="list-style-type: none"> <li>• Consumers may still neglect textile separation</li> <li>• Convenience preferences differ among consumers</li> <li>• Urban and rural areas require different collection systems</li> <li>• To be effective, this policy should be implemented in conjunction with other policies, such as providing information to consumers on importance of textile separation</li> </ul> </td> </tr> </tbody> </table>	<u>Opportunities</u>	<u>Barriers</u>	<ul style="list-style-type: none"> <li>• Increase collection rates and supply of post-consumer textiles, while lowering proportion of textiles in mixed waste</li> <li>• Improves convenience for consumers</li> </ul>
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Table D-2. Overview of opportunities and barriers of economic policies stimulating textile recycling

Economic policies	
<b>Bonus-malus system</b>	<p>In the case of recycled textiles, a bonus would be provided to producers that use recycled textiles in their production, and producers that use virgin materials are charged a malus e.g. levy or tax (Elander et al., 2017). As a result, the bonus-malus scheme would create a difference in price for products consisting of virgin materials only and products containing recycled materials. The aim of applying the bonus-malus scheme in the textile industry is to shift from using virgin textile fibers only to being financially incentivized to choose recycled textile fibers when making new products (Elander et al., 2017).</p> <p>Example: Seen in the car industry where consumers purchasing new vehicles with low GHG emissions receive a bonus, while cars with high GHG emissions are taxed at a higher rate (malus) (Regeringskansliet, 2017).</p> <p>Example: Set criteria for minimum proportion of recycled materials used in the products.</p>

	<p><u>Opportunities:</u></p> <ul style="list-style-type: none"> <li>Improves competitiveness for recycled textiles compared to products only using virgin materials, and in turn increases demand for recycled textiles</li> <li>Provides economic incentives to producers to use recycled textiles</li> </ul>	<p><u>Barriers:</u></p> <ul style="list-style-type: none"> <li>Complexity of textile industry may make it difficult to design a fair and well working system without undesirable effects</li> <li>Focuses only on recycled content and may discourage producers to increase durability and life span of the textile products</li> <li>Producers may pass the costs of the charges on to consumers instead of shifting production to include higher recycled content in their products</li> <li>Requires transparency of producers to record and report textile contents</li> </ul>
<b>Refunded virgin payments</b>	<p>Refunded Virgin Payments (RVP) is a two-layered structure where (i) the producers are charged when using virgin textile fibers in their production (e.g. per kg) and (ii) the generated revenues are allocated to producers using a certain amount of recycled textiles (Elander et al., 2017). The aim of the policy instrument is to affect investments in recycling textiles and incentivize producers to lower the use of virgin fibers (Elander et al., 2017). The policy is based on the successful ‘refundable emissions payments’ which achieved to lower the emissions of nitrogen oxide (Elander et al., 2017).</p>	
	<p><u>Opportunities:</u></p> <ul style="list-style-type: none"> <li>Improves competitiveness for recycled textiles compared to products only using virgin materials, and in turn increases demand for recycled textiles</li> <li>Provides economic incentives to producers to use recycled textiles</li> </ul>	<p><u>Barriers:</u></p> <ul style="list-style-type: none"> <li>Difficult to indicate what the right level of charge should be to provide incentives for producers to increase use of recycled textile fibers</li> <li>Producers of different sizes may have different possibilities to influence their suppliers to increase the amount of recycled content, but they would be charged</li> <li>Focuses only on recycled content and may discourage producers to increase durability and life span of the textile products</li> <li>Producers may pass the costs of the charges on to consumers instead of shifting production to include higher recycled content in their products</li> <li>Requires transparency of producers to record and report textile contents</li> </ul>

Table D-3. Overview of opportunities and barriers of informative policies stimulating textile recycling

Informative policies		
<b>Labeling requirements on recycled content</b>	<p>Each garment has labels providing information to consumers such as origin, how to clean it, and which material the garment consists of. One option is to extend the information to be communicated in the label to additional criteria such as percentage of recycled materials used (Elander et al., 2017). The aim of the policy instrument is to provide consumers with information and potentially change consumer behavior (Elander et al., 2017).</p> <p>Example: Simple logo stating % of recycled content in the product.</p>	
	<table border="1" style="width: 100%;"> <tr> <td style="width: 50%;"><u>Opportunities:</u></td> <td style="width: 50%;"><u>Barriers:</u></td> </tr> </table>	<u>Opportunities:</u>
<u>Opportunities:</u>	<u>Barriers:</u>	

	<ul style="list-style-type: none"> <li>• Enables consumers to easily identify whether products are made of recycled textiles, and potentially changes consumer behavior</li> <li>• Increases transparency</li> </ul>	<ul style="list-style-type: none"> <li>• Recycled content is not a priority of consumers when they purchase garments, when consumer like a piece of clothing it is likely that they will buy it regardless of the recycled content</li> <li>• Changing consumption patterns takes time</li> <li>• Few consumers take time to look at the labels</li> <li>• To make sure consumers understand the label and the positive effects of the use of recycled materials, some sort of advertising is crucial</li> </ul>
<p><b>Enhanced use of EU Eco-labels</b></p>	<p>Eco-labels give an indication to consumers the product complies with certain criteria, depending on the eco-label (European Commission, 2018b). Within the textile industry the environment and eco-labeling are increasingly considered and encourage the use of recycled materials. However, the amount of producers that use eco-labels is limited (Elander et al., 2017). When producers would increasingly communicate that their clothes contain recycled materials, consumers can identify which garments are more environmentally friendly (European Commission, 2018b). This may increase the demand for recycled textiles (Elander et al., 2017).</p> <p>Example: Existing eco-label with textile product groups is the EU Flower (European Commission, 2018b).</p>	
	<p><u>Opportunities:</u></p> <ul style="list-style-type: none"> <li>• Potential to increase demand for reused and recycled garments</li> <li>• Makes it easier for customers to identify which products contain recycled materials</li> </ul>	<p><u>Barriers:</u></p> <ul style="list-style-type: none"> <li>• Consumers have previously shown to have little interest and knowledge about eco-labels in textiles, increased use of eco-labels may thus have limited effect</li> <li>• Consumers are often unaware of meaning of the eco-labels</li> <li>• Expected benefits from the labels are unknown and expect costs of the label to exceed benefits</li> <li>• It is uncertain if limited uptake by producers will change</li> </ul>

Table D-4. Identifying which relevant literature sources discussing brands using post-consumer textile recycling

Source	Aim	Studies brands using post-consumer textile recycling?
<b>Kant Hvass (2014)</b>	Mapping out the emerging organizational field of post-retail practices and provide insights into the why and how of fashion companies to choose strategies to lower post-consumer textile waste.	Yes
<b>Bocken et al. (2017)</b>	Business model experimentation for circularity of a large international clothing retailer, but due to confidentiality agreement article focuses mostly on presenting how to conduct business model experimentation.	No
<b>Allwood et al. (2006)</b>	Extensive and neutral report on how the fashion industry should change looking at different aspects (i.e. working conditions, CO2 emissions and increasing waste). Also presents briefly suggestions of business models for fashion brands.	No
<b>Pal &amp; Gander (2018)</b>	Analyze emerging business models in the fashion industry to reduce the environmental impacts. The study tests the possibility that in the fashion industry SBMs will replace dominant unsustainable business models.	No
<b>Sandin &amp; Peters (2018)</b>	Reviews studies on environmental impacts of textile reuse and recycling in comparison to incineration and landfill.	No
<b>Todeschini et al. (2015)</b>	Investigates innovative business models of entrepreneurs in the fashion industry that have a sustainability as their defining characteristic.	No
<b>Watson et al. (2017)</b>	Cross-case analysis of challenges that brands have experienced when using recycled textiles and strategies they have selected to overcome these.	Yes

Table D-5. Summary of circular business models in literature

Source	(Lacy et al., 2014)	(Bocken et al., 2016)	(Smith-Gillespie, 2016)	(Watson et al., 2014)
Circular business model	<ul style="list-style-type: none"> <li>• Circular supplies</li> <li>• Resource recovery</li> <li>• Product life extension</li> <li>• Sharing platforms</li> <li>• Product as a Service</li> </ul>	<p><b>Slowing loops</b></p> <ul style="list-style-type: none"> <li>• Access/ performance</li> <li>• Extending product value</li> <li>• Classic long-life</li> <li>• Encourage sufficiency</li> </ul> <p><b>Closing loops</b></p> <ul style="list-style-type: none"> <li>• Extending resource value</li> <li>• Industrial symbiosis</li> </ul>	<ul style="list-style-type: none"> <li>• Re-make</li> <li>• Re-condition</li> <li>• Circular Sourcing</li> <li>• Co-product recovery</li> <li>• Access Performance</li> <li>• Resource recovery</li> </ul>	<ul style="list-style-type: none"> <li>• In-store collection with partner</li> <li>• Leasing of own brand</li> <li>• Resell of used own brand (either in-store or online)</li> <li>• Clothing libraries</li> <li>• Repair and fitting</li> <li>• Luxury second hand shops</li> </ul>
Source	(WRAP, 2018)	(Tukker, 2004)	(Forum for the Future and Unilever, 2016)	(Renswoude et al., 2015)
Circular business model	<p><b>Service systems</b></p> <ul style="list-style-type: none"> <li>• Service system</li> <li>• Dematerialised services</li> </ul> <p><b>Hire &amp; leasing</b></p> <ul style="list-style-type: none"> <li>• Long-term leasing</li> <li>• Short-term rental</li> <li>• Peer-to-peer</li> </ul> <p><b>Incentivized return</b></p> <ul style="list-style-type: none"> <li>• Incentivized return</li> <li>• Collection</li> </ul> <p><b>Re-use</b></p> <ul style="list-style-type: none"> <li>• Reducing consumption</li> <li>• Asset management</li> </ul> <p><b>Long life</b></p> <ul style="list-style-type: none"> <li>• Peer-to-peer</li> <li>• Long life</li> </ul> <p><b>Other</b></p> <ul style="list-style-type: none"> <li>• Made to order</li> </ul>	<p><b>Product oriented service system</b></p> <ul style="list-style-type: none"> <li>• Product related</li> <li>• Advice and consultancy</li> </ul> <p><b>Use oriented service system</b></p> <ul style="list-style-type: none"> <li>• Product lease</li> <li>• Product renting/sharing</li> <li>• Product pooling</li> </ul> <p><b>Result oriented service system</b></p> <ul style="list-style-type: none"> <li>• Activity management</li> <li>• Pay per service unit</li> <li>• Functional result</li> </ul>	<p><b>Circular</b></p> <ul style="list-style-type: none"> <li>• Closed loop recycling</li> <li>• Downcycling</li> <li>• Upcycling</li> <li>• Industrial symbiosis</li> <li>• Collection services</li> </ul> <p><b>Enabling</b></p> <ul style="list-style-type: none"> <li>• Product as a Service</li> <li>• Lock-in</li> <li>• Local loop</li> <li>• Modularity</li> <li>• Personalization</li> </ul>	<p><b>Short cycle</b></p> <ul style="list-style-type: none"> <li>• Pay per use</li> <li>• Repair</li> <li>• Waste reduction</li> <li>• Sharing platforms</li> <li>• Progressive purchase</li> </ul> <p><b>Long cycle</b></p> <ul style="list-style-type: none"> <li>• Performance based contracting</li> <li>• Take back management</li> <li>• Next life sales</li> <li>• Refurbish &amp; resell</li> </ul> <p><b>Cascades</b></p> <ul style="list-style-type: none"> <li>• Upcycle</li> <li>• Recycling</li> <li>• Collaborative production</li> </ul> <p><b>Pure circles</b></p> <ul style="list-style-type: none"> <li>• Cradle to cradle</li> <li>• Circular sourcing</li> </ul> <p><b>Dematerialized services</b></p> <ul style="list-style-type: none"> <li>• Physical to virtual</li> <li>• Subscription based rental</li> </ul> <p><b>Produce on demand</b></p> <ul style="list-style-type: none"> <li>• Produce on order</li> <li>• 3D printing</li> <li>• Customer vote (design)</li> </ul>