DUTCH FASHION STARTUPS AND THE PROBLEM OF POST-CONSUMER CLOTHING WASTE

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GRADUATION PROJECT
FASHION & MANAGEMENT
RESEARCH REPORT 2019
1. This report, as part of the graduation project aimed at attaining the BA title from the Amsterdam University of Applied Sciences, has been written and/or compiled solely by me.

2. This project report (or any amended form of it) has never before been submitted by me or anyone else in the framework of a learning assignment aimed at the attainment of a certificate or degree, within the AMFI programme or elsewhere.

3. The work that was necessary for the realisation of this project was performed entirely by me. All the data that have been collected are original.

4. All quotes from other sources are recognisable in the report by quotation marks and the sources of all my information have specially been indicated.

Date: 11 June 2019
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Signature:
The average Dutch person buys 46 items of clothing annually and disposes of 40 garments in that same year. Twenty-four items, which is 60% of this post-consumer clothing waste (PCCW), is disposed along with non-textile household waste, where the garments are incinerated (Maldini, et al., 2017). The other 40% is collected separately for reuse or recycling, but is not always used optimally and may be downcycled, incinerated or sent to a landfill later (Ellen MacArthur Foundation, 2017).

This research highlights the possibilities for Dutch fashion startups to help eliminate PCCW in the Netherlands. For this research, eight Dutch fashion startups and three professionals within the field are interviewed. The Dutch fashion startups were not aware of the magnitude of the problem of PCCW. Even though they wanted to solve the problem, they did mention barriers and problems. They admit to a lack of knowledge about the topic, so time consuming research is needed, especially since they believe there is a lack of easily accessible information and knowledge sharing about this topic. Furthermore, they link solving the problem immediately to higher costs for the business, and they miss connections with other stakeholders that are needed to eliminate PCCW, such as recycling companies or recycled fabric suppliers.

Post-consumer clothing waste can be minimized by extending the lifespan of garments, by maximizing the amount of times that a product is used before disposal. This is accomplished by designing garments with a focus on the purpose and longevity of a product. The lifespan of garments can also be extended by using lease models, since lease models make greater profits the more times they can rent out a garment. A shift to renting, therefore implies a shift towards garments that are better made, since improving the quality is beneficial for the business. Additionally, offering repair services to customers and reselling second-hand slows the creation of PCCW by stimulating longer active use. As soon as a garment cannot be used in its original form, the materials of the garment can be re-used, by creating new products out of it.

To eliminate PCCW, garments must be recycled. Recycling is the only method that allows the material to begin the life cycle again. There are two different methods of fiber-to-fiber recycling: mechanical and chemical. However, recycling comes with difficulties, including the (unclear) input of the feedstock such as the presence of harmful or restricted chemicals and other substances and the use of blends and the lack of transparency about the composition of the garments, including finishes and trimmings. Furthermore, it is often difficult and time-consuming to deconstruct a garment if the garment consists of multi-materials, trimmings or threads of another composition than the main fabric. Innovation and the scaling up of recycling processes are hindered by a lack of demand for recycled materials and by the minimal collection of PCCW.

Startups help simplify the recycling process by designing for recyclability. This includes the use of mono-materials or blends that can be recycled and considering the use of trimmings in the design process. Also providing full transparency about the garment, including the composition of the textiles, trimmings and materials that are used, and designing for disassembly. Furthermore, startups need to stimulate demand for recycled materials by committing to using recycled materials for their collections. This contributes to scaling up recycling methods. Also collecting PCCW from their consumers and collaborating with sorting and recycling companies stimulate the development of fiber-to-fiber recycling.

Educating the consumer is necessary to extend the life of garments and to stimulate recycling, since consumer behavior plays a critical role in the creation and elimination of PCCW.

All these different strategies that help eliminate PCCW are divided in categories based on the ease of implementation for startups. Implementing these strategies has the potential to extend the lifespan of clothing for one year. This would halve the PCCW per consumer of the startups and could save the remaining PCCW from being incinerated because of disposal with non-textile waste. The eight startups interviewed for this research could potentially save 1,161,144 garments from incineration annually.
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1. THE DUTCH CLOTHING MOUNTAIN

1. PURCHASE

46 items bought annually per person.

Source: GFK. Includes clothing, footwear and accessories.

2. USE

173 items in each personal wardrobe.

- 71% items in active use.
- 29% items were not worn in the past year.

50 items were not worn in the past year.

3. DISPOSAL

40 items are annually disposed of per person.

- 60% items are disposed with non-textile materials and therefore incinerated.
- 40% items are separately collected.

- 24 items are rewearable and suitable for the international second-hand market.
- 5 items are not suitable for reuse. These can be recycled.
- 9 items are potentially rewearable according to the consumer, but do not meet the international second-hand standards.
- 3 items per year are wasted before arriving to the consumer.

Source: MVO Nederland, CBS, Rijkswaterstaat & Measuring the Dutch Clothing Mountain. Wardrobe information is based on a small, non-representative sample. Underwear and socks are added on the basis of Euromonitor data (sets or packages of underwear account for 1 item).

Source: Measuring the Dutch Clothing Mountain. Wardrobe information is based on a small, non-representative sample. Underwear and socks are added on the basis of Euromonitor data (sets or packages of underwear account for 1 item).

Notes:
- The Dutch clothing mountain is based on a small, non-representative sample. Wardrobe information is based on a small, non-representative sample. Underwear and socks are added on the basis of Euromonitor data (sets or packages of underwear account for 1 item).
- The project ‘measuring the Dutch clothing mountain’ was funded by SiA’s KIEM-VANG programme. Download the final report here.

Figure 1.1

Sources: MVO Nederland, CBS, Rijkswaterstaat & Measuring the Dutch Clothing Mountain. Destiny of separately collected textiles is based on container analysis (non-representative sample). Pre-consumer waste calculated on the basis of MVO Nederland percentage and GfK volumes.
Traditionally, fashion works according to a linear business model, the take (raw materials), make (garments) and dispose strategy (Ellen MacArthur Foundation, 2017). The average Dutch person buys 46 items of clothing annually. In that same year, that person also disposes of 40 items. These items are known as post-consumer clothing waste (PCCW). In the Netherlands, disposal of clothes at landfills is banned. However, 24 items, which equals 60% of all PCCW, are disposed together with non-textile waste, which leads to the incineration of the garments (Maldini, et al., 2017). Valuable and non-renewable resources are used to produce garments, and the materials from the incinerated clothing are not recovered for reuse; the embedded value is lost (Niinimäki, 2019). The other 16 items, 40% of the total PCCW per person, can be divided into three different disposal categories:

- 9 Items are re-wearable and suitable for the international secondhand market.
- 5 Items are not suitable for reuse and can be recycled.
- 2 Items are potentially re-wearable according to the consumer, but do not meet international standards.

The amount of PCCW is growing both globally and domestically within the Netherlands (Maldini, et al., 2017). We buy more garments and also dispose of garments much faster than twenty years ago. From the year 2000 until 2015, the number of clothes sold worldwide has doubled, reaching a total of 1,000 billion units per year while the number of times that the clothes were worn before being disposed of has declined to an estimated ten times (Ellen MacArthur Foundation, 2017). This problem is mostly caused by the rise of fast fashion; inexpensive, low-quality clothing produced rapidly by mass-market retailers in response to the latest trends (Bick, et al., 2018). Fast fashion has therefor a negative impact on the quality of post-consumer clothing waste (Maldini, et al., 2017), (Bick, et al., 2018).

The quality of the collected post-consumer garments within the Netherlands is also decreasing because of the regulations introduced in 2009 to separate more textile waste from regular household (Maldini, et al., 2017). These regulations oblige collectors to take all textile waste without evaluating the quality at the source. As a result, they now receive more unsuitable for reuse, such as worn-out clothes, underwear, and non-clothing textiles (Maldini, et al., 2017). Also, the impact of low-quality items from fast fashion is visible within the collection rates; the overall resale value of PCCW has decreased (Maldini, et al., 2017).

Not only is the growing amount of PCCW damaging the environment, the manufacturing process is also harmful to the planet. The worldwide development, manufacturing and transportation of fashion is accountable for 1.2 billion tons greenhouse gasses, which is 10% of total global carbon emissions. Furthermore, the fashion industry is the second-largest consumer of fresh water worldwide, used for developing, dyeing and finishing fabrics. The wastewater generated during the supply chain of fashion contains toxins such as lead, mercury and arsenic. In developing countries, 90% of the untreated toxic wastewater is put back into the environment, resulting in degradation of the soil. Deforestation is another consequence of the fashion industry since the forest is used to produce wood-based fibers like rayon (Sustain Your Style, 2019) (Pandey, 2018). Incineration means this harm is done for just one life cycle. Therefore, it is important that all garment waste be separated from non-textile waste to prevent incineration. To repurpose PCCW, recycling is necessary (Le, 2018).

Alongside linear business models, circular business models are now entering the market (Silicon Canals, 2018). The circular economy is defined as a sustainable ecosystem that strives to mimic the regenerative cycle of nature. Also known as cradle-to-cradle: Regenerative and restorative, while eliminating all waste by reusing, recycling and reducing materials and products (Ellen MacArthur Foundation, sd) (Winston, 2019).

According to “The Pulse of The Fashion Industry” report, the PCCW problem is one of the most impactful problems on the environment caused by the fashion industry, yet the focus on solving this problem is currently on the bottom of the list (Lehmann, et al., 2018). Solving this problem will help the environment, but disruptive solutions are needed. Startups can bring these disruptive solutions to the market more easily than large long-existing companies. This gives startups the potential to be an example for the big players in the industry or to become the big players themselves and transform the linear fashion industry into a circular ecosystem (Start-up Delta, 2017) (Blank, 2017).
The aim of the present study is to eliminate PCCW within the Netherlands. This research is focused on what the possibilities are for Dutch fashion startups to contribute to this aim. The results of this study will be used to develop an online platform specifically for Dutch fashion startups that helps them realize this aim.

**AIM**

**MAIN QUESTION**

What are the possibilities for Dutch fashion startups to contribute to eliminating post-consumer clothing waste within the Netherlands?

**SUB-QUESTIONS**

- What are the barriers and problems that Dutch fashion startups face when considering eliminating PCCW?
- How feasible are the existing strategies for extending the lifetime of garments for Dutch fashion startups?
- What are the difficulties of recycling PCCW and are these difficulties influenced by the behavior of Dutch fashion startups?
- How feasible are the measures that minimize these difficulties of recycling PCCW for Dutch fashion startups?
1.4 METHODOLOGY

TO ANSWER THE MAIN- AND SUB-QUESTIONS, PRIMARY AND SECONDARY RESEARCH HAS BEEN DONE.

PRIMARY RESEARCH

Primary data is collected by interviewing Dutch fashion startups and professionals within the field of PCCW.

Interviews were conducted with Dutch startups that focus on sustainability but do not focus on eliminating PCCW within their business. The interviews included the founders of the following brands:

- Anita Palacios - Maium (25 March 2019).
- Ciara Shah - Verse Good Store (22 March 2019).
- Daan Ubach - Unrobe (26 March 2019).
- Iris Skrami - Renoon (23 March 2019).
- Maaike Groen - Miss Green (29 March 2019).
- Mike Koudijs - Supermegaflex (26 March 2019).
- Noor Veenhoven - Project CECE (19 March 2019)

Interviews were also conducted with professionals within the field of PCCW and circular economy:

- Gwen Cunningham - Lead Circle Textiles Program at Circle Economy, Sustainability Coordinator at AMFI (1 April 2019).
- Irene Maldini - Designer, teacher, researcher and first writer of “Measuring the Dutch clothing mountain” report (2 April 2019).
- Bert Van Son - Founder of MUD Jeans (1 April 2019).

SECONDARY RESEARCH

Secondary data was retrieved from online and offline literature. The online sources are mostly located by the use of Google Scholar. Google Scholar is a search engine, where you can search across many disciplines and sources: articles, theses, books, abstracts and court opinions, from academic publishers, professional societies, online repositories, universities and other web sites. To determine which sources to use for this research report, the following criteria are taken into account: The publication date and the connection to PCCW, the Dutch market and fashion startups. Also is the credibility of the sources is assessed, by looking at the publishers and writers of the literature.

This research report is mainly based on the following publications:

REPORTS

- **Measuring the Dutch clothing Mountain** – By Lectoraat Fashion Research & Technology, – Partners HvA (CREATE-IT applied research), MODINT, Saxion, Circle Economy, Sympamy, MVO Nederland, (Maldini, et al., 2017).
- **Textile Recycling Technologies, Colouring and Finishing Methods** – By UBC Sustainability Scholar, (Le, 2018).
- **Fiber-to-fiber recycling** - By WRAP (Waste and Resources Action Programme, (WRAP, 2019).
- **Sustainable clothing** – By WRAP (WRAP, 2018).

BOOK

- **Sustainable fashion in a circular economy** - By Kirsi Niinimäki, (Niinimäki, 2019).
1.5 REPORT STRUCTURE

CHAPTER 1 / INTRODUCTION
The first chapter provides background information about PCCW and the Dutch situation of this problem and it explains the relevance of this report for the industry/stakeholders. It gives an overview of the main- and sub-questions and explains the aim, the purpose and the foundation of this research report.

CHAPTER 2 / BARRIERS & PROBLEMS
What are the barriers and problems that Dutch fashion startups face when considering eliminating PCCW?

The first sub-question entails understanding the perspective of startups towards eliminating PCCW. This sub-question explores what prevents startups from eliminating PCCW by examining the problems and barriers they see. The outcomes are deduced from eight interviews with the founders of different Dutch fashion startups.

CHAPTER 3 / EXTENDING CLOTHING LIFETIME
How feasible are the existing strategies for extending the lifetime of garments for Dutch fashion startups?

This chapter provides an overview of the strategies for minimizing PCCW in the fashion industry by extending the lifetime of garments. The strategies are divided over the first three value cycles of a circular economy: maintain and repair, reuse as a product and reuse as a material. Every strategy is clarified by an example of a fashion company that has implemented this strategy, and it indicates how easy the strategies are for a startup to implement.

CHAPTER 4 / RECYCLING PCCW
What are the difficulties of recycling PCCW and are these difficulties influenced by the behavior of Dutch fashion startups?

There are many strategies that reduce PCCW, but to eliminate it, recycling is necessary. This chapter explains what the difficulties are for recycling PCCW and assesses if Dutch fashion startups can influence these difficulties with their behavior.

How feasible are the measures that minimize these difficulties of recycling PCCW for Dutch fashion startups?

An information gap between recycling requirements and startups is detected. This chapter presents strategies that have a positive influence on the difficulties that are discovered by answering the previous sub-question and maps how feasible these strategies are to implement for Dutch fashion startups.

CHAPTER 5 - CONCLUSION
What are the possibilities for Dutch fashion startups to contribute to eliminating PCCW within the Netherlands?

In the conclusion, the main question is answered according to the results of my sub-questions. Relationships and contradictions between the outcomes of the different sub-questions are highlighted and explained. Furthermore, the chapter reflects on the extent to which the objective has been achieved and assesses whether further research is needed.
1.6 LIMITATIONS

The results of this research should be evaluated by considering several limitations:

**Chapter 2 / Barriers and problems**
This chapter focuses on the barriers and problems that Dutch fashion startups see when considering eliminating PCCW. However, the reader should bear in mind that the study is based on eight interviews with fashion startups and not on all Dutch fashion startups. This information may not be accurate for all Dutch fashion startups. The awareness of these eight startups about PCCW is determined according to questions about the global situation instead of the Dutch situation since the data concerning the Dutch situation had not yet been gathered at the time of the interviews.

**Chapter 3 / Extending clothing lifetime**
This chapter examines existing strategies for extending the lifespan of clothing. However, the strategies presented are a selection of the strategies currently in the market. These strategies are not the only methods to extend the lifetime of garments or eliminate PCCW.

**Chapter 4 / Recycling post-consumer clothing waste**
This chapter uses studies conducted in European countries other than the Netherlands. It is assumed that recycling companies manage the same difficulties with recycling PCCW in the rest of Europe as in the Netherlands.
WHAT ARE THE BARRIERS AND PROBLEMS THAT DUTCH FASHION STARTUPS FACE WHEN CONSIDERING ELIMINATING PCCW?
2.1 INTRODUCTION

WHAT ARE THE BARRIERS AND PROBLEMS THAT DUTCH FASHION STARTUPS FACE WHEN CONSIDERING ELIMINATING PCCW?

Some Dutch fashion startups such as Loop, a life and ReBlend are circular and eliminate PCCW at the core of their businesses. However, this chapter examines the perspective of Dutch fashion startups that focus on sustainability in some way, but not specifically on eliminating PCCW within their business. The goal is to determine what prevents Dutch fashion startups from eliminating PCCW even when they care about the environment. Therefore, I interviewed the founders of eight startups: Windwardmade, Project CECE, Verse Good Store, Renoon, Maium, Supermegaflex, Unrobe and Miss Green to understand the barriers they see to eliminating PCCW. This chapter is based on these eight interviews, so it cannot be considered representative of all Dutch fashion startups. It does provide an indication of their perspective towards this problem. During the interviews, various answers were repeatedly discussed. This indicates that startups often struggle with the same barriers and problems regarding eliminating PCCW. Figure 2.1 presents the division of these answers. The six most recurring implications are explained in detail, while the other four are mentioned briefly.

During the eight interviews, 43 (100%) barriers and problems were mentioned. There was a lot of overlap in the mentioned implications, allowing them to be divided into 10 different categories. The percentages shown in the circle diagram are based on how many of the interviewed startups mentioned the same barriers and problem during the interviews. The lack of knowledge was mentioned by all eight startups, while transparency was mentioned by only one start-up.

2.2 BARRIERS & PROBLEMS

Knowledge

Before barriers and problems for Dutch fashion startups are discussed, the awareness of PCCW of the startups is determined*. A lack of recognition of the problem could be a reason why a startup is not focusing on eliminating PCCW.

All the participants recognize PCCW as a problem within the fashion industry, but a lack of knowledge was detected. The outcomes presented in figures 2.3, 2.4 and 2.5 (page 11), indicate that the startups interviewed do not have a full understanding about the magnitude of the global problem of PCCW and the opportunities to improve by recycling and reusing (conclusion interviews Dutch fashion startups, 2019).

The startups acknowledge that there is a lack of knowledge about solutions to eliminate PCCW. Multiple participants answered that they do not know how to start tackling this problem within their business. A recurring question that arose from the founders was: “How can we help?” Every one agreed that researching possible solutions is needed. Other questions that arose were, for example, “Which strategies already exist in the market?”, “Which suppliers offer recycled materials?”, “What are the requirements for recycling?”, “Are consumers willing to invest time and effort to bring clothes back to a clothing collection point?” (conclusion interviews Dutch fashion startups, 2019).

These questions can be answered by conducting research. For example, a study focused on consumer attitudes and communication in circular fashion was conducted in which the participants were intentionally chosen not to be particularly interested in recycling nor did they consider themselves very “green” consumers. The participants were interviewed and educated about circular fashion, and the results illustrated that they see closed-loop recycling as “cool” and “a good thing to do”. The participants are interested in finding new uses for their garments and are diligent about returning their clothes for reuse but emphasized that ease and simplicity increase their motivation (Kaisa Vehmas, 2018).

* This awareness is determined based on the global situation (figure 2.2) instead of the Dutch situation.
GLOBAL MATERIAL FLOWS FOR CLOTHING IN 2015

- **>97% virgin feedstock**
  - PLASTIC (63%)
  - COTTON (26%)
  - OTHER (11%)

- **53 million tonnes**
  - ANNUAL FIBRE PRODUCTION FOR CLOTHING

- **73% landfilled or incinerated**

- **12% lost in production**

- **0.5 million tonnes**
  - microfibre leakage

1. Recycling of clothing into the same or similar quality applications
2. Recycling of clothing into other, lower-value applications such as insulation material, wiping cloths, or mattress stuffing
3. Includes factory offcuts and overstock liquidation
4. Plastic microfibres shed through the washing of all textiles released into the ocean

Source: (Ellen MacArthur Foundation, 2017)
Although the startups recognized PCCW as a major problem within the fashion industry, tackling this problem within their business models has not been their main priority. Time was given as a key barrier to solving this problem in every interview (conclusion interviews Dutch fashion startups, 2019).

“Starting or running a startup is complex in general, and especially when focusing on sustainability. Eliminating PCCW is even one step beyond that” (Interview Anita Palacios, 25 March 2019). A lack of knowledge about solutions for eliminating PCCW was recognized. Startups need to do research to develop the knowledge and skills necessary. This includes, for example, researching circular design strategies, consumer behavior and recycling requirements.

This information can partly be gathered online, but also by following workshops, talking to consumers or collaborating with textile recycling companies. The startups state researching this topic is time consuming and results in less time to focus on other aspects of the business.

However, the amount of time needed to understand the solutions available is not long. By reading reports such as the “Pulse of the Fashion Industry report” and “A New Textile Economy,” the basics can be understood in a few days of reading (Ellen MacArthur Foundation, 2017) (Lehmann, et al., 2018). To fully implement one or multiple strategies in a business, more time is necessary depending on the strategies and the original business model and approach. Although time is seen as a barrier, the startups had a positive attitude towards investing time in this topic, as long as it is not at the expense of other aspects of the company. They do say that eliminating or minimizing PCCW should become a priority (conclusion interviews Dutch fashion startups, 2019).

Cost
Keeping costs low is crucial for startups, especially if they do not yet have high revenue streams (Interview Anita Palacios, 25 March 2019). Often, the founders of the companies still have a second job to ensure enough income (conclusion interviews Dutch fashion startups, 2019). The founders immediately link eliminating PCCW with greater costs (conclusion interviews Dutch fashion startups,
Connections & relationships
Startups mention that a network of stakeholders is needed to eliminate PCCW, which entails having connections with sorting and recycling companies, suppliers of recycled materials, repair services or other people with an expertise in eliminating PCCW (conclusion interviews Dutch fashion startups, 2019).

Also, strong customer relationships are needed in their eyes; to close the loop of clothing waste, consumers need to contribute to the goal. It requires loyal customers willing to invest time in helping the startups eliminate PCCW by, for example, repairing their clothes and returning their garments for recycling. Multiple startups mentioned that they think that consumers are not as likely to bring back the products if they receive no benefits from it (conclusion interviews Dutch fashion startups, 2019). Ciara Shah, founder of Verse good store, voices concern about consumers’ willingness to actively participate in reducing PCCW; “Because of the fast fashion industry, consumers nowadays are less loyal than in the past and they often have a lack of emotional attachment to products. This makes it probably harder to involve them in this process, but not impossible.” (Interview Ciara Shah, 22 March 2019). However, brands could see it as their responsibility to educate consumers and thereby build strong customer relationships that are also beneficial for generating sales (Australian Government, 2018).

The startups do not have all the connections necessary to eliminate PCCW, and making connections and building relationships with them is mentioned as difficult and time consuming (conclusion interviews Dutch fashion startups, 2019). Examining this lack of connections from a problem perspective, it can be solved.
All interviewed startups see their lack of knowledge about eliminating PCCW as a problem. They partly blame this on the barriers: “lack of easily accessible information” and a “lack of knowledge sharing.” However, it became clear that not all startups have delved deeply into this topic yet and that, in contradiction to their statements, there is much literature available to help them build the right skillset to eliminate PCCW. There is not a lack of easily accessible information but rather a lack of bundled information and a lack of communication between publishers and startups. Their lack of knowledge can also be linked to the other problem that arose: the absence of connections among different stakeholders such as circular business experts, recycling companies or suppliers of recycled textiles.

Another important finding was that the startups immediately link implementing strategies for eliminating PCCW to extra time and cost, both scarce elements for a startup. In the eyes of the startups, recycling technologies are not developed enough to recycle all fabrics or to create fabrics that meet their quality and functionality requirements.

Despite the barriers and problems that they see, the startups were open to embracing the idea of contributing to solving the problem of PCCW in the Netherlands. They see the long-term benefits for both businesses and the environment as they recognize circularity as the future for fashion. However, at this stage, circularity still feels difficult to achieve. The most common remark was that they did not know how to tackle the problem yet.
CHAPTER 3 / EXTENDING CLOTHING LIFETIME

HOW FEASIBLE ARE THE EXISTING STRATEGIES FOR EXTENDING THE LIFETIME OF GARMENTS FOR DUTCH FASHION STARTUPS?
3.1 INTRODUCTION

HOW FEASIBLE ARE THE EXISTING STRATEGIES FOR EXTENDING THE LIFETIME OF GARMENTS FOR DUTCH FASHION STARTUPS?

Post-consumer clothing waste is strongly connected to the end-of-use stage (Morten Lehmann, 2018). The end-of-use stage in a linear business model is the end-of-life stage since the products will not be included in a new life cycle (Shyam Ramkumar, 2018). The circular economy, on the other hand, demonstrates that there was a big gap between the first end-of-use stage and the end-of-life stage (figure 3.1), (Verdickt, 2018).

The end-of-use stage can be improved by both extending the end-of-use stage by maximizing the amount of times that a product is used before disposal and by focusing on a new life cycle for the product (M. Lehmann, 2018). These strategies can be divided into the four value cycles of the circular economy that must be followed in the order presented in figure 3.2. In this chapter, different strategies that focus on the first three value cycles are explained.

3.2 CYCLE 1: MAINTAIN & REPAIR

Design

Currently, clothing design and production seldom consider what will happen when clothes cannot be used anymore (Ellen MacArthur Foundation, 2017). Companies have a positive influence on the problem of PCCW by taking the full lifecycle of garments into account during the design process (Lehmann, et al., 2018). Below a selection of design strategies that slow the creation of PCCW are shown.

Design with a purpose

It is important that designers consider product attachment and trust of the consumer. Companies should aim to produce items that are fully appreciated and used actively throughout the product’s life. Designers need to ask themselves what purpose the product is meant to serve. Who is it for, how will it be used and when will it be used? It does require more market research into consumer needs, but this will likely lead to more sales and less dead stock since the products will better match consumer wishes. On-demand production, in the form of made-to-order and made-to-measure can be part of this strategy as well (Circular Economy, sd), (Conny Bakker, 2014), (Niinimäki, 2019).

Design for longevity

Designing for durability means that garments can resist damage without breaking down. For example, garment construction, resistance to surface abrasion and colorfastness need to be considered in the design process. Brands can set minimum quality standards aligned with a product’s purpose (WRAP, 2018), (Circular Fashion, 2018). Designing for durability might increase production costs since the development process includes more tests, and the materials used are often more expensive compared to less durable alternatives. However, it also increases the performance of the garment, which means it can be passed on in the selling price since Dutch consumers are often willing to pay more for higher quality products (Santander TradePortal, 2019). Therefore, it is important with this strategy that the quality standard is clearly communicated to the consumer.

Teym is a Dutch brand that is taking many of the design aspects into consideration. They only release one non-seasonal product per year. They put full focus on one garment at the time, which helps them to create the 'perfect' item that lasts. Also, they do not work with any discounts and educate the consumers about all aspects of the products, from raw material, to production method, until care instruction (Teym, 2019).
Designing for long lasting style means that the relationship among style, time and audience is considered in the design; timeless designs appeal to a wide audience for a long time and are, therefore, more suitable for reuse. Examples include the use of basic colors, minimalistic design and easy fit (WRAP, 2018), (Circular Fashion, 2018). Timeless designs are easy to implement; they do not automatically lead to extra costs or time for the business since there are no major changes within the design process, other than researching which styles are “long lasting styles.” However, the appearance of clothing in this category must fit the brand image to sell.

Design for repair and redesign through disassembly means that parts of the product can easily be replaced or repaired for longer use, for example replaceable linings from coats because these will wear out first (Circular Fashion, 2018), (WRAP, 2018), (Sustainable design cards, sd). This way of designing requires extra skills and a different working method. Stock is also needed, or startups need to be able to produce the parts customers need on demand (Niimimäki, 2019). This strategy, therefore, requires strong relationships with local suppliers and factories but might include extra costs.

Educating consumer
Clear communication about care instructions and repair and reuse options available to the consumer is key. Educating consumers on how to improve the usage of a garment increases its durability and prolongs its lifetime, lowering its overall footprint (WRAP, 2017), (M. Lehmann, 2018). This is, for example, being done by providing instructions on the label on how to wash, dry, repair and dispose the garments. Even suggestions for “do it yourself” recycling can be a playful way to increase customer awareness, such as: “Hole in your shirt? Cut it in pieces and use it as a cleaning cloth!” (Interview Irene Maldini, 2 April 2019). Furthermore, this information can be verbally communicated in-store or online via the website and social media platforms. These initiatives require minimal extra costs and time, which makes them easy to implement. Educating the consumer is crucial, not only to increase awareness and lower the environmental footprint, but also to involve the customer actively in the transition of the fashion industry toward a circular model (M. Lehmann, 2018).

Loop a. life stimulates the circular textile industry by creating circular clothing, but also by evolving their customers in the process. They organize clothing sorting- and collection events, and workshops for their customers in order to help them with making better decisions (Brightloops B.V., 2019).

Nudie Jeans offers lifelong repair service to their customers. Through its Repair Shops, customers can return their damaged jeans for repair right at the shop instead of sending them in. This initiative has proven to be a great success. In 2018 they repaired 55.173 pairs of jeans, collected 10.557 pairs for reuse for new products and as patching material, which means they saved 44.000 kg of clothes from being thrown away and saved 386.000.000 liters of water (Nudie Jeans, 2019)

Repair services
Encouraging self-repair by incorporating repair instructions and repair-kits into clothing sales extends the life of garments. Another option is offering repair services in-store. This provides high customer service but does require investments in time and money, since there is a need for skilled people and shop space. However, this strategy has proven successful for creating customer loyalty (Nudie Jeans, 2019). Establishing relationships with your local tailor is a cheaper and less time consuming solution and is, therefore, beneficial and feasible for startups. Extending the life of clothes by just nine extra months of active use would reduce carbon, water and waste footprints by around 20-30% each (WRAP, 2018).

3.3 CYCLE 2: RE-USE AS A PRODUCT

Lease
In the last few years, business models focused on leasing clothes have increased (Liebe, 2018). Different lease strategies, which can be divided into three main categories, are now on the market: ad hoc, long-term lease and permanent subscriptions. As lease models make greater profits the more times they can rent out a garment, a shift to renting models also implies a shift towards products that are better made, since improving the quality is beneficial for the business (Hooker, 2018). According to Bert van Son, founder of MUD Jeans, offering subscriptions through leasing systems requires well-organized administration work and new financial skills, since the cashflow of the products varies from the current linear business models. He explains: “Working with a lease model, requires a short-term availability for cash, since it takes longer until you receive the full sale price. However, if the quality is high, it extends the use-phase and therefore leads to higher margins per product in the long term” (Interview Bert Van Son, 1 April 2019).
Ad hoc
This model provides clothing to the consumer for a short period of time (often between three and seven days) for a one-time payment of a certain amount. In this way, the value and durability of the garments is captured by distributing the clothing use between many different people. This model is mostly used for high-end clothing that people wear on special occasions.

Long term
A long-term rental or lease makes it possible for consumers to pay for their garment via a predetermined amount per month. The clothes can be brought back any time. This model is mainly used for clothes with high quality and durability. It is beneficial for consumers because they do not have to invest in the full price in one go, and there is less risk involved since they do not own the garment (Ellen MacArthur Foundation, 2017).

Subscription
This model is not focused on one specific item that is rented or leased, but on the convenience of swapping among multiple items. Consumers pay a monthly fee that provides them the opportunity to use one or multiple items at the same time depending on the subscription, and it offers the possibility of swapping products. This model has been successful for people that desire frequent changes in their wardrobe since it gives them chance to wear high-quality goods while avoiding the high costs of buying them (Ellen MacArthur Foundation, 2017).

Filippa K introduced a pilot lease, where consumers could rent catwalk-items for a maximum of 4 days for €40 euros, including cleaning and shipping costs. Since it was the catwalk collection, the women garments were only available in size Small and Men’s in size Medium (RetailNews, 2018).

MUD Jeans has been providing a ‘Lease A Jeans’ option since 2013, for a monthly fee, with a repair service included. Customers can either keep the jeans after twelve months or return them and switch to a new pair. They stay connected with the brand and the model encourages customer loyalty (Interview Bert Van Son, 1 April 2019).

Reselling secondhand
Another way to minimize PCCW is by reselling secondhand clothing. The percentage of people that buy secondhand clothing is growing among all generations, but generation Z is leading with a growth percentage of 46% in 2018 compared to 2017, reaching a total percentage of 37% (REINHART, 2019). Multiple businesses are tapping into this opportunity (Elven, 2018). Different models can be distinguished:
- Supporting consumer to consumer sales (physically or via online platforms).
- Brands opening new sales channels by selling used clothing of their own brand (online or at brick and mortar stores).
- Shops selling secondhand clothing from multiple brands (online or at brick and mortar stores).

Implementing these different strategies in a business has different requirements, but all include opening a new sales channel. This highlights the need to research and review all the tasks that need to be accomplished to make a sale. This is time consuming and likely adds extra costs.

3.4 CYCLE 3: RE-USE AS MATERIAL

HulaaLoop, is a Dutch start-up, offering a subscription model on sustainable clothing outfits for babies and kids. Since kids grow fast, they outgrow their clothes fast as well, which makes this model very cost-efficient. HulaaLoop offers both new as well as secondhand clothes and there are also different price options for the number of outfits needed (Hulaaalop, 2019).

Remanufacturing
If the post-consumer garments are no longer suitable for reuse in their original state, there might be possibilities to reuse the material in another form. This can be done by consumers themselves, but businesses can also tap into this opportunity. This step can give garments a full new lifecycle without the need for fiber recycling or the use of much energy, water, dyes or chemicals (Niinimäki, 2019). It has great benefits for the environment. However, the PCCW needs to be collected, which might require new connections, and it takes time to prepare the PCCW for the new life cycle, such as sorting and cleaning. Furthermore, it requires the same process as adding a new style to the collection.

United wardrobe offers consumers a platform to resell their used clothing. In 2017, they reached half a million sales within one year. In 2018 they experience a huge increase in sales, whereas the same volume of sales was already achieved in June (Terra, 2018).

Pōur is a Dutch brand that uses old work uniforms from the road and bridge construction sector, to create different types of bags and aprons. They encourage the consumer to return their products when they do not use them anymore, in order to recycle them into new products again (Pōur, 2019).
3.5 CONCLUSION

HOW FEASIBLE ARE THE EXISTING STRATEGIES FOR EXTENDING THE LIFETIME OF GARMENTS FOR DUTCH FASHION STARTUPS?

Chapter 2 and figure 2.1 present ten different barriers and problems mentioned by the startups regarding the elimination of PCCW. A lack of knowledge, time and easily accessible information, increasing costs, a lack of connections and a lack of awareness and effort of the consumer might all occur when implementing these strategies to extend the lifetime of garments.

The boxes next to the body text provide short business examples of fashion startups that are successfully executing the different strategies for extending the lifetime of garments, meaning that all the strategies are feasible for fashion startups. However, to implement these strategies in a business, the Dutch startups need to overcome some of the barriers that they identified. There are differences in how easily the strategies are implementable for startups, which results in different practicality levels:

**Very easy to implement** No direct changes in the business model and minimal need for time, resources and new connections. These strategies are the basis of eliminating PCCW.

- Designing with a purpose
- Designing for long lasting style
- Educating the consumer
- Encouraging self-repair or connections with local tailor

**Easy to implement:** No major changes in the business model, but extra investment in knowledge, connections or costs required, which might take longer to implement.

- Designing for durability
- Designing for repair and redesign through disassembly
- Remanufacturing

**Implementable:** These strategies make substantial changes to the current linear business model or change them completely in a circular model. All are time consuming because they require research and may require new organizational and financial skills, investment of money, new connections and consumer effort.

- Repairing in-store
- Reselling secondhand
- Leasing
WHAT ARE THE DIFFICULTIES OF RECYCLING PCCW AND ARE THESE DIFFICULTIES INFLUENCED BY THE BEHAVIOR OF DUTCH FASHION STARTUPS?
4.1 INTRODUCTION

WHAT ARE THE DIFFICULTIES OF RECYCLING PCCW AND ARE THESE DIFFICULTIES INFLUENCED BY THE BEHAVIOR OF DUTCH FASHION STARTUPS?

It is important that companies maximize the duration of each value cycle and the number of value cycles a garment passes through. But recycling is always the last value cycle that a product must pass in order to make fashion circular and eliminate PCCW.

Both the interviews and research reports indicate that fiber-to-fiber recycling at scale is, among other factors, hindered by a disconnect between the design process and recycling processes (Ellen MacArthur Foundation, 2017), (conclusion interviews Dutch fashion startups, 2019). This chapter explains the different recycling methods and the difficulties that recycling companies experience for recycling PCCW and assesses if startups can influence these difficulties.

4.2 HOW IT WORKS

There are two main methods of fiber-to-fiber recycling: mechanical and chemical. Figure 4.1 visualizes the PCCW flows in the Netherlands and it illustrates how the two recycling processes work.

Mechanical recycling
Mechanical recycling, has existed for centuries and is still the most commonly used form of recycling (Ellen MacArthur Foundation, 2017). In the mechanical recycle process, the original fibers of the fabrics are shortened by the shredding process, which weakens and reduces the quality of the new yarns. Therefore, the recycled fibers are often blended with virgin fibers to meet quality standards (Ellen MacArthur Foundation, 2017), (Le, 2018). The mechanical recycling process cannot filter out dyes and contaminants or separate blends, which causes problems if textiles contain harmful substances as recycling these textiles can lead to the continued exposure to these substances. This may occur when using textiles that were produced before current regulations about substances were enacted (Ellen MacArthur Foundation, 2017). A positive aspect of mechanical recycling is that there is minimal or no use of water, chemicals or dyes since recoloring is not needed because the garments are usually sorted by color before the shredding process. This results in a broad assortment of color possibilities from slightly different colored fibers (University of the arts of London, Centre for Circular Design, 2016).

Chemical recycling
Chemical recycling can recycle materials into new materials of virgin or near virgin quality. However, this process is still in the developmental stage and is not yet technologically or economically mature (Le, 2018). Chemical recycling of cellulosic fibers has been developed with ongoing advancements in technology towards scale-up, while the recycling of synthetics (nylons and polyesters) includes some full-scale developments but is limited to a few suppliers (Centre for Circular design, 2016). Nevertheless, developments in demonstrated technologies are expected to advance in the coming decades, including possibilities for blends (Le, 2018) (Ellen MacArthur Foundation, 2017).

4.2.1 (UNCLEAR) INPUT OF FEEDSTOCK

Fiber-to-fiber recycling at scale is hindered by multiple factors. The most important one, which startups can influence, is the uncertainty about the input of the feedstock. The manufacturer’s specifications determine a garment’s suitability for recycling.

Chemicals and substances
During the different production stages of fibers and textiles, many chemicals are used. Chemicals are introduced in the fiber production process, more are added during the dyeing processes and when the finishes and treatments are added to the fabrics (Le, 2018). These chemicals have the potential to obstruct recycling processes. However, recyclers have trouble identifying the specific impacts of a chemical (Ellen MacArthur Foundation, 2017). The current system is not transparent about which chemicals are used in textiles, especially when looking at PCCW. This lack of information makes it harder to expand the knowledge base about problematic chemicals for recycling and makes it more difficult to improve recycling processes (Le, 2018). However, this lack of information does not relieve companies of the obligation not to distribute materials on the Restricted Substances List (ECHA - European Chemical Agency, 2019).

Blends
‘Measuring the Dutch clothing mountain’ report aims at sharing knowledge relevant for sustainability-oriented studies and actions in the Dutch apparel sector, with a focus on clothing volumes. According to this research, at least 37.3% of the garments collected in the Netherlands are made from material blends (Maldini, et al., 2017). Blended materials are harder to recycle than mono-fiber materials. However, it is possible to recycle some blends, depending on the composition and distribution of the blend. Figure 4.2 provides examples of current commer-
OVERVIEW AND EXPLANATION OF THE DUTCH CLOTHING RECYCLE SITUATION AND PROCESSES

START

235 Tons
TOTAL Post-consumer clothing waste

23 Tons
Exported 'original'
Unsorted or roughly sorted post-consumer clothing, in which any non-textile items have been removed

13 Tons
recyclable grades export

9.5 Tons
Dispose non-reuseable non-recyclable

6.6 Tons
Clothing re-use locally

61.6 Tons
Sorted locally

90 Tons
Collection (feedstock)

28.3 Tons
Clothing re-use export

145 Tons
Disposed in general house-hold waste

9.6 Tons
Recycled locally

Sorting per raw material

9.6 Tons
Garment preparation

Chop
Pull

Mechanical recycling

Cut
Needle-punch

Chemical recycling

Removing dyes

Depolymerize
Chemical structure of the material is either broken down partially or fully into molecules

Repolymerize
Making a new chemical structure from the molecules

Sorting per color

Web formation
The arrangement of fibres in a sheet or web

Carding
Garments are mechanically pulled into their raw fibre state

Weave/knit

Cut

Bond

Spin

Chemical recycling

Shoddy or blends
Shoddy is the name for new cloth created from woollen waste and other recycled fabric.

Wipers
Down cycled for reuse for example cleaning purposes.

Other no-woven

High-value Down cycling (Closed loop)

Low-value Down cycling (Open loop)

Total Export
64.3 Tons

Value loss (for the Netherlands)

Incinerate

Landfill (banned in the Netherlands)

Down Cylindering (Open-loop)

Down Cylindering (Closed-loop)

21

Figure 4.1

This visualisation is a combination of the following literature:
(Le, 2018), (Maldini, et al., 2017), (Smits, et al., 2018).
cial processes, patented processes and processes under development for recycling Polyester, Nylon Cotton, Wool and blends of these materials (Le, 2018). The requirements for recycling vary between different recycling methods and can also vary per recycling company. Recycling requirements can change quickly as recycling processes mature or when new methods arise. Another important aspect behind the possibility of recycling blends is the desired new life cycle of the garment. For example, the strength of a fiber needed for a knitted t-shirt is much lower than for woven jeans (Interview Gwen Cunningham, 1 April 2019). Blends that are harder to recycle into high-quality fabrics (closed-loop recycling) are often usable for downcycling purposes (open-loop recycling), which is better than incineration (Le, 2018).

### Recycling Options: Polyester, Nylon, Cotton, and Wool

<table>
<thead>
<tr>
<th>Fiber</th>
<th>Mechanical recycling</th>
<th>Minimum Input Composition %</th>
<th>Chemical recycling</th>
<th>Minimum Input Composition %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyester</td>
<td>Closed-loop</td>
<td>† 100 (f2f)*</td>
<td>Closed-loop</td>
<td>†, ** 70-80 /100* No requirement** (i.e. various polycotton blend ratios)</td>
</tr>
<tr>
<td>Other applications (open-loop or downcycled)</td>
<td></td>
<td>Varied * (mainly post-industrial)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nylon</td>
<td>Closed-loop</td>
<td>† 100 (f2f)* Must be same type (6 or 6,6)</td>
<td>Closed-loop</td>
<td>* (only for Nylon 6) 100*</td>
</tr>
<tr>
<td>Other applications (open-loop or downcycled)</td>
<td></td>
<td>Varied * (mainly post-industrial)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>Closed-loop</td>
<td>† 100 (f2f)*</td>
<td>Closed-loop</td>
<td><em>,</em>* (regenerated cellulose, not 100% recycled cotton product) 100* No requirement** (i.e. various polycotton blend ratios)</td>
</tr>
<tr>
<td>Other applications (open-loop or downcycled)</td>
<td></td>
<td>Varied * (mainly post-industrial)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wool</td>
<td>Closed-loop</td>
<td>&gt;80 (f2f)*</td>
<td>Closed-loop</td>
<td>Not available</td>
</tr>
<tr>
<td>Other applications (open-loop or downcycled)</td>
<td></td>
<td>30-100* (application dependent)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* commercial scale ** developed/demonstrated  
Source: (Le, 2018)  
Figure 4.2

### Information-lack of material composition

Within the research of ‘Measuring the Dutch clothing mountain’, 30.4% of the collected garments were missing the care label, so the material could not be classified. Since the suitability of the recycling method per garment is determined by the fabric composition, the lack of this composition is problematic in the Dutch recycling industry (Le, 2018), (Maldini, et al., 2017).

### Deconstructing multi-material garments and trimmings

The use of (decorative) trimmings that are difficult to detach makes it harder to deconstruct a garment and slows the recycling process. Also, the material of the trimmings influence the recycling process since it determines if all parts of a garment can be recycled. The same applies to the use of sewing thread of a different material than the main fabric or the use of multi-materials; it reduces the speed and efficiency of the recycling process (Rengel, 2017), (Niinimäki, 2019). An analysis of collected PCCW from the ‘Measuring the Dutch clothing mountain’ report indicates that around half of the garments contained trim, and 21.2% of the garments were made of more than one material. Examples of this category are jackets with lining or jeans with patches (Maldini, et al., 2017).

### 4.2.2 OTHER DIFFICULTIES

#### Lack of demand for recycled materials

There is a lack of demand for recycled fabrics, which is connected to the low prices of virgin materials (Design Longevity, sd). Clothing recycling can only evolve if there is a clear demand for recycled fibers from public procurers and the industry in general (Rengel, 2017). Increasing the demand for recycled materials accelerates the development of recycling methods. It will radically increase markets for non-wearable clothing items such as stained- or damaged garments, since these products can now be recycled into new textiles and serve as new resources for clothing brands. This improves the opportunity for collectors to capture the value from these non-wearable garments in the form of revenue and it would rescue these textiles from incineration. Increasing the demand for recycled materials would bring economies of scale, encourage innovation and stimulate recycling companies to improve their quality and processes (Ellen MacArthur Foundation, 2017).

#### Low collection & recycle rates

Together with the demand for recycled materials, the collection of PCCW needs to be scaled-up (Ellen MacArthur Foundation, 2017). Figure 4.1 illustrates that only 4% of the total PCCW flows into a local recycling process, and only 0.1% undergoes local fiber-to-fiber recycling. It is estimated that 36 tons out of the 90 ton of discarded textiles collected annually in the Netherlands are suitable for fiber-to-fiber (closed-loop) recycling (Smits, et al., 2018). This number will increase if collection rates grow. At the moment, 27% of the total PCCW is exported to other countries and 66% is incinerated.
4.3 CONCLUSION

WHAT ARE THE DIFFICULTIES OF RECYCLING POST-CONSUMER CLOTHING WASTE AND ARE THESE DIFFICULTIES INFLUENCED BY THE BEHAVIOR OF DUTCH FASHION STARTUPS?

Startups do not influence the technical difficulties of mechanical recycling including the fact that mechanical recycling has a negative impact on the strength and quality of the new yarns and that this method cannot filter out dyes and contaminants or separate blends. Also, the technical difficulties of chemical recycling cannot directly be improved by the startups. However, since this method is not yet mature, and the speed of innovation goes together with the demand for recycled materials. Startups can have a positive influence by stimulating demand.

The uncertain input of the feedstock is something Dutch fashion startups can positively influence since the feedstock comes in part from Dutch fashion startups. Startups can also contribute to reducing the difficulty of low collection and recycling rates. Which measures help simplify these difficulties is explained in the next sub-question.
How feasible are the measures that minimize these difficulties of recycling PCCW for Dutch fashion startups?
4.4 MEASURES TO MINIMIZE DIFFICULTIES

HOW FEASIBLE ARE THE MEASURES THAT MINIMIZE THESE DIFFICULTIES OF RECYCLING PCCW FOR DUTCH FASHION STARTUPS?

Currently, a disconnect between design and recycling processes is recognized. The way clothing is made, including the choice of the fabric composition and the construction of the fabric and garment, is rarely based on the recyclability of the different options (Ellen MacArthur Foundation, 2017). The following sections focus on how startups have a positive influence on eliminating PCCW by focusing on simplifying the last value cycle of the circular economy: recycling.

Materials

Different raw materials require different recycling methods, which must be considered at the sourcing and designing stage (Circular Fashion, 2018). The easiest way to improve the chance of recyclability is using (recycled) mono-materials. This means that a fabric is made out of one raw material, such as cotton, wool, nylon or polyester. These mono-materials are suitable for closed-loop recycling, but blending the output with virgin fibers might be necessary to achieve the desired quality (Le, 2018). However, not all mono-materials are suitable for recycling; there is, for example, no recycling method available for silk (Interview Gwen Cunningham, 1 April 2019). Furthermore, there are some blends that have the potential to be recycled into high-quality fabrics. Polyester-cotton blends are now possible to recycle, but the options for recycling companies are still limited (Hendrikz, 2017). Fabrics that contain at least 60% wool or more, are also suitable for recycling, depending on the recycling company, recycling method and the desired quality of the output (Le, 2018). Using materials that are easy to recycle does not necessarily increase costs, but it does make companies consider fabric characteristics. It requires research into all the possibilities for fabric recycling and research into which of these fabrics would correspond with the required characteristics of the desired style. Furthermore, it might lead to the need of new relationships with different fabric suppliers.

Trimmings

The trimmings used on garments affects their recyclability. There are easily implementable measures that help simplify the recycling process but do not necessarily demand (much) more time or higher costs (Interview Irene Maldini, 2 April 2019):

- Reducing the amount of trim, for example, by avoiding unnecessary trimmings such as decorative zippers or buttons. The use of trimmings make it harder to deconstruct the garment because separation of the trimmings from textile takes time.
- Using trimmings that are easier to detach to speed up the recycling process. For example, sewn-on buttons are easier to remove than buttons that are pressed into the fabric.
- Choosing trimmings that are easy to recycle, for example, by avoiding trimmings that consists of multiple materials.
- Using sewing threads of the same composition as the main material. Using sewing thread of another material has a negative effect on the speed and efficiency of the recycling process.
- Using care labels that do not itch or show, since those are the two main reasons why consumers cut out the labels.

Design for Disassembly

Designing for disassembly is discussed in chapter three to increase repair and redesign possibilities, but it also simplifies the process of separating different materials within one garment for recycling purposes. For example, a garment such as a winter coat must consist of multiple materials to function. Wear2 is a new technology that helps disassemble garments by using a unique yarn. Designing the garment with this yarn makes it possible to easily separate material parts that are sewn together using microwave energy (Wear2, 2018). Separating materials is also done in other ways, for example, by choosing easily removable seam or weave techniques (Niinimäki, 2019). Designing for disassembly requires research into different assembly methods and might increase the time needed for the design process. Furthermore, it is important to communicate the information about the disassembly process within the garment.

Dyes, finishes and prints

The presence of colors, dyes, finishes, prints or toxic chemicals can make recycling more complex. However, currently there is not much information published on which specific substances impede recycling (Le, 2018). Therefore, it is best to
4.4.2 STIMULATE DEMAND FOR RECYCLED MATERIALS

Increasing demand for recycled materials brings economies of scale, which stimulates recycling companies to improve their quality and processes, leading to innovation (Ellen MacArthur Foundation, 2017). Startups can influence the demand for recycled fabrics by making commitments to use recycled materials for their collections. This replaces the need for virgin materials, which lowers the climate impact because recycled materials use less water and fewer chemicals and emit less CO2 than the production of virgin materials. Furthermore, using materials made from recycled PCCW, helps to reduce the volume of PCCW, by giving it a new life cycle (Rengel, 2017), (M. Lehmann, 2018). However, recycled materials are currently more expensive than virgin materials (Design Longevity, sd).

4.4.3 CLEAR COMMUNICATION

The lack of transparency is one of the most significant issues for clothing recycling. It is important that brands provide as much information as possible about their garments. This includes providing labels not only with information about the fabric, but also about the trim, yarns, dyes, finishes and prints. There are also tools available in the market, such as EcoChain, that help with capturing this information about garments making it easier to communicate clearly to recyclers (Interview Bert Van Son, 1 April 2019), (EcoChain, 2019).

4.4.4 EDUCATING THE CONSUMER

In 2012, 145 tons of textile waste within the Netherlands was incinerated because this textile waste ended up in general household bins. Although the collection of textiles has increased since then, improving collection volume is still necessary (Maldini, et al., 2017), (Interview Irene Maldini, 2 April 2019). Since the consumer is responsible for the number of garments that eventually arrive at the recycling facilities, it is important to involve them in the process of eliminating PCCW. Consumers must first be made aware about the problem of PCCW. This can be done via multiple channels, such as social media, brands websites and within brick and mortar stores. Additionally complete information should be included on clothing labels. Instead of only providing information about the main materials, labels can include instructions on how to use, disassemble, dispose of or recycle the product. Also advising the consumer not to cut out the care label of clothes is very important to simplify the recycling process, since 30.4% of collected clothes do not include a care label anymore (Maldini, et al., 2017).

4.4.5 CLOTHING COLLECTION & COLLABORATION WITH SORTERS AND RECYCLERS

Clothing collection bins within stores are becoming more common, and opportunities to return old clothes to companies are increasing. In this way, businesses endeavor to recapture the value of the materials by reusing these garments through remanufacturing or recycling. Companies try to increase collection numbers by rewarding consumers with discount vouchers or other rewards (M. Lehmann, 2018). However, waste and environmental management specialists criticize the motives of these incentives among the fast fashion players, since the goal might be to increase store traffic by offering discounts (Matteis, 2018). Take-back incentives are useful to minimize PCCW, especially when brands not only collect garments and bring them to sorting companies, but when different stakeholders collaborate.

Collaboration between fashion brands, sorting companies and recycling companies helps disseminate information among all parties. It stimulates information exchange and increases transparency about requirements and possibilities for recycling, which improves the quality of and transparency about the feedstock and output. This information exchange speeds up innovation and can lead to higher recycling rates (M. Lehmann, 2018) (Le, 2018).
HOW FEASIBLE ARE THE MEASURES THAT MINIMIZE THESE DIFFICULTIES OF RECYCLING PCCW FOR DUTCH FASHION STARTUPS?

This category requires the minimal number of barriers and problems to overcome mentioned in chapter two. The strategies require minimal extra cost and time and do not necessarily require extra resources nor connections. This means that every startup should be able to implement these strategies in their current business model.

**Very easy to implement:** No direct changes in the business model and minimal need for money, time, resources and new connections. These strategies form the basis of eliminating PCCW.

- Using materials that are recyclable
- Improving recyclability by considering trimmings and labeling during the design process
- Educating the consumer

**Easy to implement:** Implementing these strategies demand more investment of time and money, in order to expand knowledge and build up new relationships with stakeholders. There are no major changes in the business model needed.

- Designing for disassembly
- Eliminating the use of dyes, finishes and prints or offering full transparency about the substances that are used
- Stimulating demand for recycled materials, by using them in their collections
- Clear communication to all parties involved (designer, consumer, textile collectors, textile recyclers)

**Implementable:** Implementing these strategies in combination with previous mentioned strategies, makes it possible to change a linear business model into a circular business model. In order to achieve this, not only new connections need to be accomplished but also collaboration is required. Implementing these strategies, brings the need for research, together with new organizational skills, investment of money and the consumers need to be involved in the whole process.

- Clothing collection initiatives
- Collaboration with sorters and recyclers
WHAT ARE THE POSSIBILITIES FOR DUTCH FASHION STARTUPS TO CONTRIBUTE TO ELIMINATING PCCW WITHIN THE NETHERLANDS?
5. CONCLUSION

WHAT ARE THE POSSIBILITIES FOR DUTCH FASHION STARTUPS TO CONTRIBUTE TO ELIMINATING PCCW WITHIN THE NETHERLANDS?

This report provides a broad variety of measures and strategies that contribute to eliminating PCCW for startups. However, during the interviews with the startups, there were ten barriers and problems mentioned that prevent the startups from taking measures to eliminate PCCW. Despite that, the startups acknowledge the need for change in the industry and want to be part of this change. This means that they need to overcome these barriers and problems starting by searching for and embracing solutions. The possibilities for startups discussed in the previous chapters are divided into three different categories based on the number of barriers and problems that they are willing to reconsider for implementing these strategies.

Possibility 1: Very easy to implement: No direct changes in the business model is required and there is only a minimal need for money, time, resources and new connections. To extend the life of garments, the startups should always design with a purpose and for long lasting style. They should encourage self-repair and offer repair services at a local tailor. To improve recyclability, they need to use materials that are recyclable and take trimmings into consideration during the design process. Since eliminating PCCW is reliable on consumer behavior, it is necessary to involve them in the process by educating them about PCCW, the possibilities and importance of extending the life of garments and by giving tips on how to disassemble, dispose or recycle the product.

Possibility 2: Easy to implement: In order to eliminate PCCW, more measures are needed. Designing for durability is an important aspect that every startup should strive for to extend the life of garments. Other options are remanufacturing and designing for disassembly, which can also improve the recyclability of garments. The use of recycled fibers and materials in their collections cannot be avoided when the goal is to eliminate PCCW. Furthermore, the use of dyes, finishes and prints should be avoided as much as possible. If the use of these substances is unavoidable, startups need to demand full transparency about the materials from the fabric suppliers, since it is important that there is clear communication about these substances to all parties involved, including sorting and recycling companies. These measures make no major changes in the business model but do require extra investment in knowledge, connections or costs and might, therefore, also take longer to implement.

Possibility 3: Implementable: Although it might be possible to eliminate PCCW by using the measures of possibilities 1 and 2, there are strategies that lower the barrier for consumers to contribute and that give the startups more insight into the direct results. This includes offering in-store repair services and clothing take-back incentives, reselling garments secondhand or the use of lease models. An important aspect is investment in starting collaborations with different stakeholders, such as textile sorters and recyclers. Strong relationships will contribute to clear communication, one of the missing factors to scale up recycling processes. Implementing these strategies is more time consuming because they require research and preparation and create large changes within the linear business models of the startups. They might also require new organizational and financial skills and investment of money.

The measures mentioned in the different categories will not completely eliminate PCCW on their own, but they are all necessary steps towards that goal. Multiple measures need to be taken to design all PCCW out of the business. A focus on giving unlimited new life cycles to products is necessary, which can only be achieved by recycling.

Currently, the overall collection rate of PCCW is only 38%- 40% (figure 4.1 & 5), and the flow of locally recycled PCCW is only 4% (figure 4.1). Even though Dutch fashion startups are only responsible for a small amount of all PCCW that is generated within the Netherlands, they can still contribute to eliminating PCCW.

Below an ideal hypothetical situation is sketched in order to clarify how small changes can have a big impact.

Looking back at the current average disposal habits (figure 5.1), imagine that the startups would implement the strategies for extending the lifetime of garments explained in chapter three and that this extends the lifetime of the garments of their consumers with one year. This would reduce the number of annually disposed items with 50%, with the result that the average consumer would now dispose of 20 garments annually instead of 40. Currently 60% of these disposed garments, which now equals 12 garments, end up with non-textile waste and are incinerated (figure 5.2). By educating the consumer about how to dispose their clothing and by improving the recyclability of the garments, the startups could reduce this number of garments to zero (figure 5.3).

Comparing the new situation (figure 5.3) with the current situation (figure 5.1), it shows that the startups have the potential to save 24 garments from incineration per consumer per year, by keeping the PCCW in the loop by local recycling. The eight fashion startups have together at least a customer reach of 48.381 people. In the hypothetical situation that these consumers only buy at these eight startups, or if the startups' influence on their consumers' behavior is also applied on the garments that the consumers bought from other brands, they can rescue 24 garments per person from incineration per year. The eight startups can in the ideal hypothetical situation, prevent 1.161.144 garments from being disposed with non-textile waste each year and therefor save it from incineration.

By acting responsibly over the PCCW generated by their business and by using recycled materials within their business to stimulate demand, the startups decrease the total amount of PCCW generated within the Netherlands and they give the right example to other businesses and consumers. This research shows that there are many possibilities for startups to contribute to eliminating PCCW, as long as they are willing to make changes in their current behavior. Further research into the exact costs of the implementation of the strategies can be done in the future.
5.1 ELIMINATING POST-CONSUMER CLOTHING WASTE

5.1 Current situation
This is the current situation according to the research of ‘The Dutch clothing mountain’. In order to eliminate PCCW, the disposing pass needs to slow down and no garments can be incinerated.

Figure 5

Source: (Maldini, et al., 2017)

5.2 Extended lifetime of garments
By extending the lifetime of garments with one year, the 40 annually disposed garments per person will be reduced to 20 items. However, if the current disposal habits continue, there will still be 12 garments incinerated immediately.

5.3 Correct disposal
In order to eliminate PCCW, clothing can not be incinerated. The 12 garments that are now disposed with non-textile waste, need to get a new life cycle, by local recycling.
ALL SOURCES THAT ARE USED FOR THIS RESEARCH


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