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Circularity in the Fashion Industry: A Study on Recycling Practices and End-of-Life Textile Recycling Among Fashion Retailers

Bachelor's thesis in International Logistics

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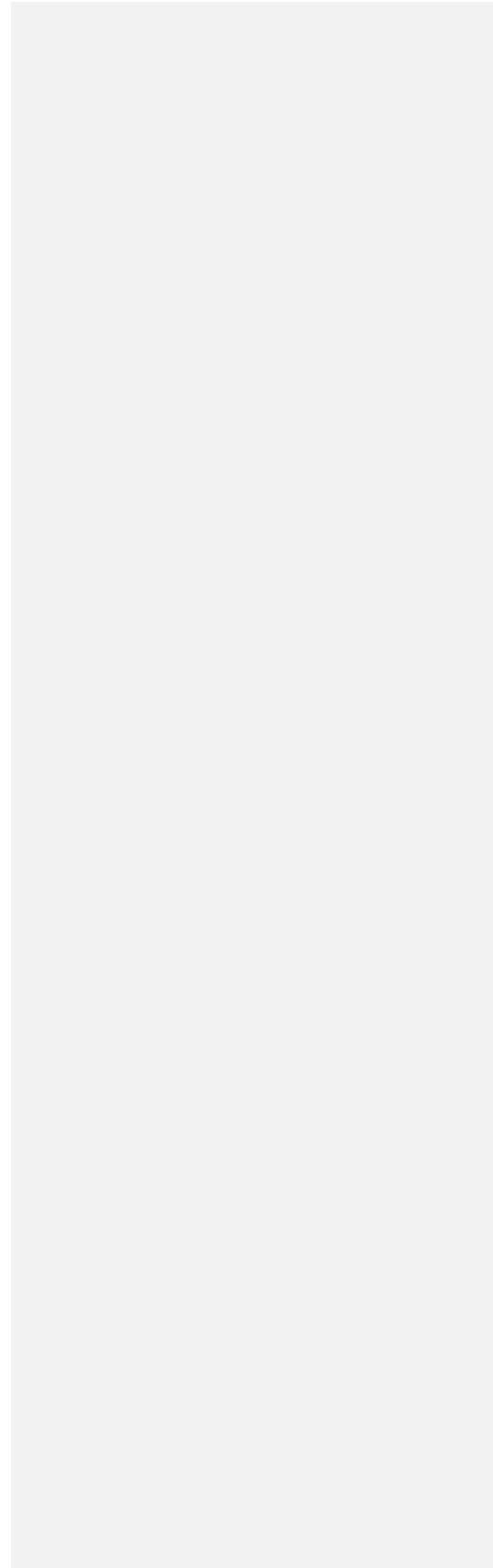
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SUMMARY

This thesis investigates the circularity strategies and solutions that are being employed in the fashion textile industry to address its environmental impact. The first research questions explore the main circularity strategies, with a specific focus on the role of textile recycling in achieving circular practices. The second research question examines the optional channels and solutions that fashion retailers are utilising to achieve circularity. The findings suggest that while textile recycling is an important aspect of circularity, it should be combined with different methods in order to achieve a circular economy. Additionally, fashion retailers are utilising various channels and solutions in order to achieve circular business models. The results highlight the importance of a holistic approach to circularity in the fashion textile industry, including need for a combination of strategies that are beyond just textile recycling. The scope of this research will be limited to the fashion textile industry, rather than the entire textile industry. This study focuses on the challenges, opportunities as well as solutions related to textile recycling and extending the life cycle of textiles from a fashion retail perspective.

Key words: fast fashion, textile industry, recycling, consumer behaviour, circularity strategies

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1. INTRODUCTION

The textile industry is among the largest and most rapidly expanding industries in the world. In the recent 4 decades, the business model within fashion retailing has developed from classic fashion into fast fashion. This results from a number of factors, including globalization and advancing technology (Koszewska, 2018). Former, traditional fashion business models emphasize producing low quantities of clothing that are designed to last for generations, focusing on durability in terms of both the materials and design- encouraging garments to be passed down through generations.

In contrast, the fast fashion concept revolves around producing high quantities of clothing that are designed to have a shorter lifespan, often sold at competitive prices. The term, fast fashion, can be defined as readily available, inexpensively made fashion of today. The term "fast" refers not only to the rapid speed production, manufacturing and sales of the clothes, but also to the quick disposal of these items by consumers (European Commission 2022).

Consequently, retailers are in constant competition to offer customers the latest fashion trends by reducing production times and creating designs more rapidly than before (Kotahwala, 2020). This fast fashion approach can be seen in prominent fashion retailers like Zara and H&M. In later years, these retailers regularly introduce between 15 to 25 clothing collections annually. In the case of H&M, collections are updated weekly. This trend signifies a consistent upward trajectory in the average number of collections launched and the number of garments purchased by the average consumer (Koszewska, 2018).

1.1. Sustainability concerns

The fashion and textile industry's garment manufacturing process generates a range of environmental consequences throughout the garments' life cycle. The most impactful stages of the life cycle are the production and transportation of the garments (European Commission, 2022). These stages relate to vast use of energy, water and hazardous chemicals, as well as CO₂ emissions.

In the years Between 2020 and 2025, the global fashion market is expected to grow from \$1.5 trillion to \$2.25 trillion in turnover (Centobelli et al., 2022). The transformation of raw materials into complete garments results in a substantial generation of waste and water utilization. The fashion industry is responsible for approximately 20% of the world's total water consumption, equivalent to 79 billion cubic meters annually. Additionally, it generates 10% of the total CO₂ emissions globally, at 1.7 billion tons, and produces 92 million tons of textile waste (Centobelli et al., 2022).

The fashion industry poses issues in terms of environmental, but also social sustainability. One example is the increasing amount of outsourced manufacturing among fashion retailers. The Spanish fashion retailer Zara is for example moving almost 15% of their production from Europe to Turkey in order to achieve lower manufacturing and labour costs. The workers at the manufacturing sites face several challenges, the items need to reach the consumer in a matter of weeks or even days, compared to a few years ago, when the time frame from design to customer was several months (Atik & O. Ertekin, 2022; Cataldi et. Al., 2010; Joy et. Al., 2012). Pressure of this kind, causes companies to ignore policies that ensures the workers well-being,

prioritizing a seamless operation of the supply chain at the expense of factory workers suffering from working overtime on minimum wages.

1.2. Consumer behavior concerns

In addition to the direct environmental effects of fast fashion, consumers increasingly demand competitive prices. This is associated with the low-quality garments that characterize the fast fashion industry. Consequently, garments are disposed of quickly due to their reduced price and quality, which, paradoxically, encourages customers to consume even more with the same budget (European Commission, 2022). With this in mind, fashion consumption has more than doubled in recent time. A study conducted by Greenpeace (2017) states that the average consumer buys 60% more clothing items today than they did 15 years ago, discarding it twice as fast.

This shift in consumer behaviour, and the constant wish for new fashion is exploited and encouraged by the largest actors in fashion retail. As exemplified by Atik & O. Ertekin in the *Journal of Social Marketing* (2023), producing limited edition clothing collections has grown to become a more frequently used strategy in order to fuel consumption and consumers' fear of missing out on new clothing items. The clothing brand Zara, has become known to create urgency among their customers by constantly introducing new collections in this manner, encouraging customers to browse their online stores every few weeks.

Apart from fuelling the desire for new clothing among the consumers, fast fashion retailers promote consumption by limiting the durability of their clothes, encouraging a constant renewal of consumers wardrobes. According to Joy et al. (2012), 10 washes is the benchmark for how many washes a garment is supposed to last among fast fashion retailers.

Fashion is in fact no longer cherished as an artisanship, neither among retailers, nor among consumers. Instead, it is regarded as any disposable product. Exclusive designer- and luxury clothing items has lost interest among, in particular young, customers. Fast fashion is regarded as a satisfactory alternative since the collections respond fast enough to latest trends. Given that individual consumption is the driving force of organizational production, the fast fashion industry is growing as a result of consumer demand (Joy et al., 2012a).

The textile industry, particularly the fast fashion sector, is considered a significant contributor to the issue of sustainable consumption and is in need of transformation. Consequently, the reduction of textile waste and the reuse of end-of-life textiles as raw materials are identified as targets in the 11th Article EU's Waste Framework Directive (European Union, 2018).

One possible solution would be recycling end-of-life textiles. This circularity practice provides a number of benefits, including reducing waste, conserving resources, and reducing greenhouse gas emissions. However, recycling textiles can also be a complex and challenging process, requiring the effective management of a number of different components, including collection, sorting, processing, and distribution (Jäämaa & Kaipia, 2022). From a supply chain perspective, the challenges of recycling of end-of-life textiles are arguably even more significant, since the entire lifecycle of the textile needs to be taken into consideration, from production to disposal.

1.3. Aim of the study

This research aims to from one end, explore the subject of circularity in the fashion textile industry, in particular the significance of different circularity strategies in relation to textile

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recycling. The second approach will be to identify the current state of art regarding circularity in the fashion textile industry, to further identify challenges, opportunities, and prospects of it.

The research will also examine the role that companies within fashion retail, play in promoting textile recycling and the measures they have taken to encourage customers to recycle and manage their end-of-life textiles. The findings of this research will provide insights into the challenges and prospects of circularity and textile recycling, while contributing to a deeper understanding of the future of circularity in the fashion textile industry and the measures and knowledge required to improve and broaden the concept.

1.4. Research questions and Background

RQ1: What are the main circularity strategies in the fashion textile industry and what significance does textile recycling have in relation to them?

The fashion industry is one of the biggest polluters globally. The environmental impact of the industry is mainly linked to the disposal of textile waste generated by the supply chain. Recent studies show that the number of consumers willing to pay a higher price for more sustainable fashion pieces, is increasing. Although, this trend as it stands right now is not substantial enough to deal with the textile waste problem. The current linear model of textile production, use and disposal is an unsustainable approach as it negatively influences energy and water usage, while contributing to the emission of harmful chemicals into the atmosphere (European Commission, 2022). There are several challenges associated with recycling end of life textiles, such as the composition of the fabrics, the lack of effective and efficient collection systems and the limited availability of recycling technologies. It is imperative to identify the opportunities and challenges associated with recycling end of life textiles. How these means can be achieved could perhaps be obtained with collaborations between the stakeholders in the supply chain. The answers to this research question aims to contribute to the existing foundation of literature on the topic of developing strategies to overcome these challenges and improve the sustainability of textile recycling.

RQ2: What optional channels and solutions are being used to achieve circularity among fashion retailers?

The fashion industry is vastly realising its need to move to a circular economy model. This requires the efficient and sustainable management of textile waste and the recycling procedure. Fashion retailers can play a crucial role in providing consumers with channels to dispose their end-of-life textiles. The incentives for retailers to promote recycling and achieving sustainable growth are still up for debate. Several channels for retailers to provide the disposal of end-of-life textiles are available such as in store take back programs, mail-in recycling, and partnerships with third party organisations such as non-profit third-party organisations. Each of the channels currently available, are met with their respective benefits as well as their challenges, these may be dependent on customer behaviour, financial standpoint, logistical considerations and technological advancement. Therefore, it is essential to evaluate and examine the various channels and solutions available.

1.5. Delimitations

In this thesis, the scope of research will be limited to the fashion textile industry, rather than the entire textile industry. The study focuses on the challenges, opportunities as well as solutions related to textile recycling and extending the life cycle of textiles from a fashion retail perspective. Further, the legislative perspective on circularity will be on a surface level.

2. THEORETICAL BACKGROUND

The aim of the theory section in this report is to elaborate on the concept of circularity. This involves providing a background to- and defining the term circular economy, while also discussing the current state of trade practices and the global economy as a contrasting point.

As mentioned in the introduction of this thesis, the consumption of fashion items and clothing has increased, and to provide a historical perspective, this theory section also discusses the transition from the conventional fashion business model to the fast fashion business model, considering the role of consumer behaviour in driving this shift.

Furthermore, the report, and in particular the theory section will examine the resulting consequences of this transformation. The consequences touched upon will include the environmental effects, as well as effects on consumer behaviour. The theory section will discuss different alternatives of measures and activities for achieving circularity in the fashion industry- providing an overview of the available options and their ranking in relation to each other- in terms of significance to achieve circularity. As a central part of this thesis, textile recycling as a circularity practice will be further investigated, which aligns with, in particular, research question number one. Whilst doing so, also including an analysis of consumers' role in the shift toward circularity, and the demand which drives production.

2.1. From Take-Make-Dispose to a circular economy model

Walter Stahel and Genevieve Reday (1981) sketched the vision of circular economy, an economy that goes into loops and how it would impact resource scarcity, waste prevention and further economic competitiveness. This was later built upon with additional research on the subfields that rose up in connection with the term of 'Circular economy' being further established.

In 1972 an non-governmental organisation called the Club of Rome published the work Limits to Growth containing studies how humans used earth's natural resources. The researchers used computer modelling to develop a number of possible outcomes that could result from actions being taken or not undertaken, by the year of 2100. The key takeaways from the study were that the human ecological footprint cannot continue to grow for another 100 years (Dennis L. Meadows et al., 1972). One of the scenarios in this study was described as the business-as-usual scenario, where humans would continue on without paying much thought to the challenges of exponential growth.

2.2. Consensus on the concept of circular economy

Looking at the prospects of circularity, an important aspect to take into consideration is the fact that there is still no consensus on the concept of circular economy. There is no uniform definition of the term, which makes it hard to interpret in academic settings, as well as for businesses. According to Prieto-Sandoval et al. in Towards a Consensus on the Circular Economy (2018), there is a need for a unified understanding of circular economy, to further fuel the implementation of it across industries. The background to this statement, is the varying definitions to be found in literature around the concept of circular economy.

To contribute to such an understanding, Prieto-Sandoval et. Al. (2018) states the definition of Circular Economy as: *An economic system that represents a change of paradigm in the way that human society is interrelated with nature and aims to prevent the depletion of resources, close energy and materials loops, and facilitate sustainable development through its implementation at the micro (enterprises and consumers), meso (economic agents integrated in symbiosis) and macro (city, regions and governments) levels. Attaining this circular model requires cyclical and regenerative environmental innovations in the way society legislates, produces and consumes.*

The foundation of this definition is based on four different components, with one of them being to state the importance of recirculation of resources and energy and the recovery of value from waste, which is particularly relevant for this thesis.

2.3. Strategies that mitigate circularity and their significance

First off, in order to establish a circular system, there are various strategies or options for retaining value to achieve circularity in the textile industry. One can utilize several models, and there have been various attempts to establish a system of evaluating these strategies. Presented below, is a figure referred to as the 10R: s, which was developed as part of a case study of the national Circular Textile Mission in the Netherlands (Reike et al., 2022). The study was conducted with the objective of mapping the transition needed, to attain the national target of achieving complete circularity in the Netherlands by 2050. In this model, the different practices are ranked according to their significance in the transition toward circularity in the textile industry.

Figure 1

List of 10 Circularity Strategies (Value Retention Options)

R#		Examples of (market) actor activities
R9	Re-mine	e.g., grubbing, cannibalizing, selling old products and materials (global South)/ high-tech extraction, reprocessing of waste in landfills or sewers (global North)
R8	Recover (energy)	e.g., energy production as by-product of waste treatment
R7	Re-cycle	e.g., separate, sell, buy and use secondary materials
R6	Re-purpose	e.g., acquire non-virgin products/materials to, redesign, reproduce and sell product with new function
R5	Re-manufacture	e.g., use or sell replacement of key modules or components which includes wider decomposing and recomposing of products
R4	Re-furbish	e.g., use or sell replacement of key modules or components, in particular: to bring a product in line with latest technological development
R3	Repair	e.g., making the product work again by repairing or replacing deteriorated parts
R2	Re-commerce/re-use	e.g., buy or sell secondhand items, or find buyer for non-used products
R1	Reduce	e.g., use less products and materials, use longer, in particular: redesign processes/ products
R0	Refuse	e.g., refrain from using specific inputs, in particular: redesign processes/products

Note. 10 R: s, here referred to as circularity strategies or value retention options, and their definition in the right column. From "Understanding circular economy transitions: The case of circular textiles", by Reike et. al, 2022, Business Strategy and the Environment, p. 22.

2.4. Categorization and definition of the 10R circularity strategies

To further develop a comprehension of the 10R principles and their application in a circular economy, Reike et al. (2018) categorize the different practices by assigning them into three loop types, ranking them by length: short-, medium-long- and long loops. The length describes the extent to which they include the involvement of different actors and processes.

2.4.1. Closer to the customer: short loops

The short loops include the practices: *Refuse*, *Reduce*, *Resell/Re-use*, and *Repair*. This loop exists close to the customer- whether that be an individual or a business, and the 4 practices included in the scope of it, are commonly referred to as the most valuable ones for Circular economy practices.

2.4.1.1. Refuse

The practice of refusing refers to the consumption of consumers as well as producers. In terms of consumers, the choice to buy and use less is emphasized to restrain waste creation from garments as well as packaging and plastic bags. In terms of producers, the term refers to the fact that they hold the power to refuse the use of hazardous chemicals and certain design production processes that creates waste.

2.4.1.2. Reduce

This practice is applicable to consumers, producers, and in a generic manner. It refers to the reduction of waste production in all stages of a products' life cycle, contrary to R0 (*Refuse*), which suggests the complete elimination of the waste producing processes. At the customers site, there are several measures to be taken to accomplish this, and Reike et al. (2018), exemplify

this by naming pooling and shared use of products. They further suggest the term as more explicitly linked to the producers and their responsibility to use less material during the concept and design stages of the product life cycle. To accomplish this, the concept of dematerialization is mentioned as one option, where the goal is to reduce the amount of material used for one unit by e.g., using lighter materials or less materials by modifying the size of the product.

2.4.1.3. Resell and Reuse

When defining the terms of reselling and reusing, the prevailing discussion is whether it is to be regarded as reusing or reselling the entire product as well as parts of it, or only the formerly mentioned. Although, most common is to divide these practices into reselling and refurbishing. So forth, the practice of reselling and reusing is concentrated to first- and second-hand consumers or collectors of these kinds of products.

2.4.1.4. Repair

The fourth of the practices in the smallest loop defines the act of repairing to prolong the lifespan of a product. The different measures that define as repairing, can be carried out by the individual as well as businesses that specialize in repair, and non-commercial repair workshops. Reike et al. (2018), divides repair into two different categories, long-term maintenance, and ad-hoc repair.

2.4.2. Further away from the customer: medium-long loops

As mentioned, the length of the loops is to be perceived as a way of explaining the distance between the activity and the customer. In the case of medium-long loops, the activities included are usually conceived as business activities rather than directly linked to customers. Included in the medium-long loops are 3 sets of activities: refurbishing, remanufacturing, and repurposing.

2.4.2.1 Refurbish

According to D. Reike et al. in *Resources, Conservation & Recycling* (2018), the term "refurbish" is applicable when a multi-component product undergoes repair or replacement of components, while the initial structure is preserved. The final goal of refurbishment is to increase the product's quality, resetting it to its original condition, through using newer and more advanced components. It is often used on the context of vehicles like airplanes, trains, and their engines. Although the term is most used as formerly explained, there has been some interpretations of the term, that suggest the result of refurbishment being an almost completely new product- which gives it the meaning of nearly replacing the product completely.

2.4.2.2. Remanufacture

Contrary to refurbishing, remanufacturing does not guarantee restoring products to their original condition. This is explained as using recycled components in the maintenance, which means that the lifespan of a remanufactured product might not be as long as a refurbished one. The process of remanufacturing is usually carried out in an industrial setting.

2.4.2.3 Repurpose

The term "repurpose" is the least used of the different circularity activities and according to Reike et. al. (2018) it has a similar meaning to the concept of fashion upgrading in design and artist communities. Concrete examples of repurposing include cases when microchips have been made into jewellery and glass bottles turned into mugs. Repurposing is characterized by the way of reinventing the life cycle of the product.

2.4.3. Waste management: long loops

The activities included in the long loops consist of recycling, remining and recovery of energy. These activities all characterize the revolution from land mining into more sustainable alternatives where the waste is being utilized to create value instead of discarded as useless waste.

2.4.3.1. Recycling

Out of the activities in all loops, the concept of recycling is the most confusing in terms of definition. According to Reike et. al. (2018), it is used to distinguish acts of shredding, melting and on other ways extracting pure material from post-consumer as well as post-producer waste. One issue is particularly considered when recycling materials, the energy used to recycle the material, should not supersede the retained value created through recycling. Regarding the quality of the recycled materials, it is difficult to obtain an even quality level, when recycling end-of-life textiles, since they vary in quality level. So forth, recycling is to a greater extent beneficial in business-to-business relations, where quality levels are more even and reliable-creating higher quality in the secondary, recycled materials.

2.4.3.2. Recovery of energy

The term is primarily referring to the incineration of waste to produce energy, the materials bound for recovery of energy are often turned into biomass, which is then used as fuel and a source of energy.

2.4.3.3. Re-mining

Remining is performed in both developed and developing countries, and has in recent years, taken different directions. In informal situations, the practice is referred to as “cannibalization”, and poses a great health risk to the individuals performing it. When searching landfills for valuable material, such as metals, they may be exposed to hazardous substances. Although in more developed countries, the practice has taken status as an entrepreneurial activity, engaging businesses in extracting valuable resources from landfills and waste plants.

2.4.4. Similarities with the EU Waste Hierarchy

Like the model presented, the EU waste hierarchy directive ranks different options and their application in managing waste, in order to provide a framework that clearly communicates the effectiveness of each alternative in relation to the other ones.

The waste hierarchy consists of five options, all representing different approaches to waste management:

- 1. Prevention*

The first priority is to avoid generating waste overall, this can be made possible by implementing measures like creating products with longer lifespans as well as utilizing reusable packaging.

- 2. Reuse*

In the cases where waste prevented fails, the next option is reuse. This involves finding new uses for products or materials that would otherwise be discarded.

- 3. Recycling*

Recycling is defined as turning the produced waste into new products or materials. This conserves natural resources, while reducing the amount ending up in landfills.

4. *Recovery*

One of the least preferable alternatives is to utilize the waste to create energy through processes including incineration and gasification.

5. *Disposal*

The option of disposing of waste in landfills is placed at the bottom of the Waste Hierarchy, as the least preferred approach. Since it results in depletion of resources and contamination.

With the focus being to prevent waste production, the waste hierarchy aims to encourage a shift towards more sustainable waste management practices, whilst doing so, further mitigating the shift to circular economy (The European Parliament and the Council of the European Union, 2018).

2.5. Circularity in the fashion textile industry: An overview

The current system for producing, distributing, and disposing of clothing is almost a fully linear way of operating (Amicarelli et al., 2022). With the introduction of a circular economy model, the end-of-life textiles would be revived to ensure that they stay in circulation for a longer period. This can be done through utilizing the R- strategies referred to in the earlier presented model by Reike et. al. (2018), strategies as recycling, reusing, redistributing, and reducing the total amount of textiles produced and consumed.

As of today, substantial amounts of non-renewable sources are used from the initial stages of producing textiles to its end of life. The number of times a garment is worn has decreased over the last decades, with fast fashion being a big contributor to this (Igini, 2022). E. With the fast fashion industry using a linear model this leaves economic and sustainable opportunities untapped.

Contrary, in a circular economy model for the fashion textile industry, a piece of garment would be used an increased number of times than it is today, which would ensure utilization of the garments' value more effectively. This is an example of a system that would be more resilient- the input needed would decrease and the input would be made up of mainly renewable resources, shifting away from fossil-fuel-based fertilisation systems as well as the minimisation of pesticide usage. To ensure this utilization also in end-of-life textiles, it is important that some different types of fabrics are not combined in the production process, as separation in the recycling process will be severely compromised (Navone et al., 2020)

2.5.1. From linearity to circularity in the fashion textile industry: Measures prolonging the life cycle of textiles and restraining consumption

In a study conducted by Levänen (2021) it was found that the reduction in buying clothes as well as the reuse of old clothes reduce global warming potential far more than sharing a pool of clothing i.e., rental of clothing. Existing circular economy practices of reduction in textile consumption, as well as reusing old clothes were shown to be far superior alternatives to not only the practice of renting but also recycling of clothing. Only in the case where jeans were used twice the number of times, combined with environmentally friendly transport i.e., bicycle, the sharing option could compete with the other alternatives. This makes the conclusion that

sharing services must be closely allocated to the consumer for it to have any competitiveness with other alternatives.

Although at a small scale, alternative solutions for buying clothes have long been a part of the textile industry. The concept of clothing rentals has been present for decades, but it did not see public light before the 20th century, until the emergence of online clothing rentals such as *Rent the Runway* and *Gwynnie Bee*. *Rent the Runway* was one of the first online platforms evolving around clothing rental. This quickly gained traction as women were able to rent out high-end designer wear for any occasion, (Rent the Runway, n.d.).

One of the main dilemmas that complicates sustainable textile production is the decision of what material the fabric is supposed to be made up of. For instance, organic cotton is grown without pesticides, on the other hand it uses tremendous amounts of water during the production process. Recycled polyester although recycled, is still polyester which is a synthetic plastic. In the alternative circular economy approach that is clothing rentals, there is a chance of a rebound effect where the activities aimed at environmental benefits are not realized due to external factors (Levänen et al., 2021).

“A circular economy is a bigger idea than incrementally reducing the harm of our current model.” (Ellen Macarthur Foundation, 2020). The key message from this is the fact that, moving away from the linear economy model approach that is currently used within the textile industry to a circular economy model, will greatly improve the likelihood of succeeding with sustainability goals set throughout the industry.

To be able to reap the rewards from the circular approach, products shall be designed so that they can be easily disassembled at their end of life for recycling and reuse purposes. Where after maximum usage has taken place, it can be safely managed (Ellen Macarthur Foundation, 2020). The materials should first go through the so-called technical cycle loops which are reuse, repair, remaking and recycling to ensure sustainable practices, where it is then possible should go through biological loops such as composting or biodegrading to further add value.

In the current linear model of textile usage only 1% of end-of-life textiles are being recycled into new garments, this is due to several varied factors as formerly mentioned, such as the difficulty of breaking down different materials once they are already combined.

2.6. Textile recycling as a circularity strategy in the fashion textile industry

Alike other industries, the fashion textile industry operates under a linear economic model. The fashion textile industry is to be held responsible for consuming a considerable number of natural resources in the production and refinement of fibers. Between 1975 and 2017, there has been a 400% increase in the production of fibers used to create clothing items, with the fashion textile industry alone responsible for more than 50% of the total amount of fibers produced (Matthes et al., 2021)

In recent times, the manufacturing of these textiles has predominantly been subcontracted to developing countries where there is less stringent oversight of the production and refinement procedures for the textiles (Reike et al., 2022). Due to the nature of rapid changes in fashion trends and the tendency to quickly discard clothing items based on this, a significant amount of

valuable raw material is wasted every year. According to Matthes et al. (2021), out of the garments that are turned into clothing, 73% are either incinerated or sent to a landfill. Approximately 1% of fashion textiles are being recycled as of today.

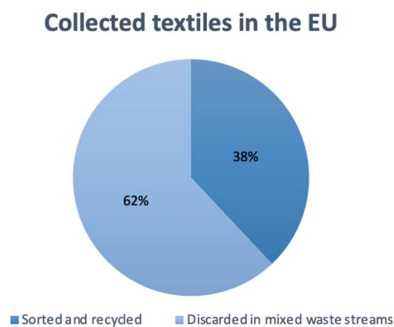
The scale of this waste, combined with the finite nature of natural resources, highlights the urgent need to move away from the linear economic model. Furthermore, the textile industry is in a constant phase of growth, because of population increase and the growing interest for fashion (Matthes et al., 2021, 206).

Looking at statistics on textile recycling in general terms, the European Commission presents in their *EU Strategy for Textiles* (2022) that only 38% of the 2.1 million tonnes of post-consumer textiles collected every year, is being sorted and recycled as of today (European Commission, 2022). This is further illustrated in Figure 2.

The EU Strategy for Textiles is of high importance when reviewing the current state of textile recycling since it provides a broad perspective of the different measures that the current establishment for textile recycling lacks. One important takeaway is the incorporation of guidelines and legislation that regulates the producer's responsibility in designing garment that aligns with the principles of circularity (European Commission, 2022).

Figure 2.

Dispersion of Collected Textiles in the EU.



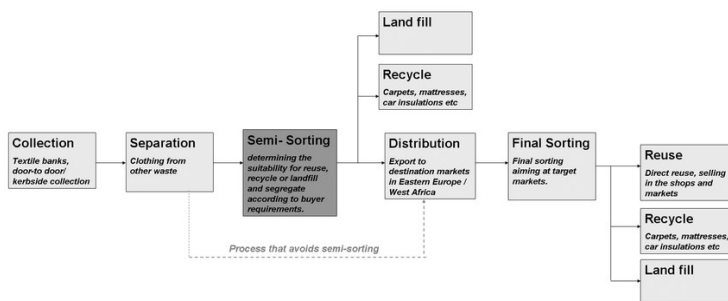
Note. The figure demonstrates the amount of textiles recycled, respectively discarded, in tonnes on a yearly basis in the European Union. Own work.

2.6.1. Textile recycling in practice

Textile recycling in its current state of art, is currently performed through several different ways. According to a Bartl & Piribauer in *Textile Recycling Processes: State of Art and Current Developments* (2019), the most labour-intensive segment of the textile recycling process is the sorting process. The textiles are sorted based on whether there is a need for product recycling, material recycling or feed-stock recycling. These three different recycling practices differ from one another based on whether the physical and chemical constitution of the material is changed throughout the process. These practices are demonstrated in Figure 3. Product recycling does not at all alter the physical or chemical constitution of the material. According to Bartl & Piribauer (2019), product recycling could for example take place through using the fibres as filling material.

Material recycling on the other hand, does alter the physical constitution of the material, while leaving the chemical processing to feed-stock recycling. Melting of polyester is one example of material recycling. In feed-stock recycling, the chemical as well as the material composition of the waste is modified, disintegrating the fibre into its smallest particles.

Figure 3.
The Process of Reusing and Recycling Discarded Clothes.



Note. Model explaining the process from collection to recycling of textiles. From” Sustainable Waste Management Strategies in the Fashion Industry Sector “, by K. Dissanayake et. al, 2013, International Journal of Environmental Sustainability, 8 (1), p.22.

2.6.2 Barriers to textile recycling

As told by the statistics, a fairly small fraction of textiles is currently being recycled. There are barriers that hinder the full utilization of this circularity practice, and this section presents a number of those barriers.

Multi-material textiles

As illustrated in Figure 2., the proportion of discarded textiles exceed 60%, and the waste streams consist of different garments that are often-times made from multi-material fibre compositions. Bartl & Piribauer (2019) state that there is a correlation between reduced complexity in garments and their recyclability, and so forth complex multi-material textiles are often discarded from the formerly used for energy recovery purposes.

Information deficiencies

Further fuelling this, is the growing issue regarding statements on the material composition of garments. They are often modified in order to give the customer an impression of the textiles

being sustainably produced. According to the European Commission (2018), up to 40% of these statements are “false or deceptive”. This opacity further complicates the sorting process, creating an element of insecurity regarding the composition of the textiles.

Attitude towards recycling

After establishing what is important to the consumer when purchasing clothes, one must also examine their attitude towards recycling. A study by Rotimi et. Al, on predictors of consumer behaviour to recycle end of life garments in Australia (2023), found that if consumers do general recycling in their household, they would be more likely to recycle their end-of-life textiles. Some of the key takeaways from this study were that individuals that express themselves more frequently through fashion, i.e., fashion being a big part of their life, would be more likely to recycle their end-of-life textiles. Further findings suggests that the more knowledgeable a consumer is of the fashion industry and its environmental impact, the more will they contribute with in terms of recycling and circularity practices (Rotimi et al., 2023).

2.6.3. The significance of consumer habits in relation to fashion textile recycling and circularity

The over production in the textile industry is difficult to tackle only by developing recycling options. According to Cantzler et al., (2020) the type of practices that involves strategies such as reduction and reusing are more complicated and require new business models, while as recycling procedures are more easily incorporated in already existing business practices. Some research suggests that new business models are in fact, not always needed when it comes to incorporating reduction and reusing strategies in the textile industries (Levänen et al., 2021). While innovative solutions can be a contributing factor to more sustainable options, it may not always be necessary. Some studies suggest that the recycling of textiles is not the most significant measure to be taken to implement a circular economy (Preferred Fiber & Materials Market Report, 2020). Referring to the circularity strategies in section 2.2., the recycling practice is ranked as number seven, among ten different strategies. This indicates that there are 6 strategies that are to be preferred before turning to textile recycling.

Before turning to recycling, there is rather the issue of over-production- that is in urgent need of reforms. Production within the fashion textile industry aligns with the customers ever increasing demand for fashion and clothing. In present time, reduction of the total amount of products in circulation should be the focus and to shift the consumer habits into this direction. The measures that are pointed out as the most efficient to steer the sector in a more sustainable direction, are the reduce and reuse practices. Reduction and reusing practices face different challenges. For instance, the reduction practice requires from the consumers to use their garment for a longer period of time, preferably as long as possible.

Although it sounds simple enough in theory, in practise it can be quite difficult. In a prolonged period of time garments may not be able to last long enough for this to be realised. For the reusing practices to be realized second-hand options closely located to the consumer should be available (Levänen et al., 2021b). To ensure environmental benefits and reduced consumption of textiles, targeting the change of consumer habits as well as supplying them with more sustainable fashion, is part of the solution. To mitigate this, one must first understand what drives the consumer demand and drives them to make their purchase of this type of mass-produced clothing, which is the consumer preference.

2.6.4. The several aspects of consumer preference

In the *International Journal of Consumer Studies*, issue 40 (2016), Harris et. Al. suggest that the presence of sustainable clothing product alternatives, is not enough to convince the customers to change their shopping habits. A number of different factors affect the choice between fast fashion and sustainable, ethical clothing. Among the most significant factors are the price, aesthetics and their knowledge of the environmental impact related to their choice.

The sustainable alternatives often compete with cheap fast fashion items, that are designed to be disposed. Furthermore, the fast fashion is often prevailing in terms of aesthetics and in general regarded as more up to date, with several collections mirroring trend shifts. In this aspect, Harris et. Al., highlight the importance of mainstreaming the sustainable clothing, instead of distinguishing it from other clothing items to make it align with a “sustainability-theme”, which creates a negative stigma.

The consumer preference, and in particular the final choice between ethical clothing and fast fashion, is not only determined by the aesthetic and price of the garment, but also the knowledge on which the choice is based on. Harris et. Al (2016) suggests that communicating the sustainability benefits clearer with consumers will affect their choice, while Bartl & Piribauer in *Textile Recycling Processes: State of Art and Current Developments* (2019) propose a similar solution that includes eco-labelling clothing.

2.7. Extended producer responsibility (EPR) in the European Union

The aim and main purpose of the Extended Producer Responsibility Framework published by the European Commission (2020), is to shift the responsibility of waste management and disposal from the consumers or local governments to the producers. This establishes a framework that can be used to hold producers accountable for their products and their environmental impact including the whole chain from design to collection and disposal.

The framework would set requirements on the design principles of, in this case, garments. This creates incentives for producers to design garments that does not complicate the recycling process in the end of the products life cycle. Eventually, if the framework comes into fruition, it will be a powerful tool in order to prevent waste creation in the first step.

2.7.1. Mandatory Ecodesign requirements

The *European Commission's strategy for sustainable and circular textiles* (2022) further recognizes the issue of overconsumption and rapid disposal of clothing textiles. It is carried by the European Commission to set a framework that provides a set of measures and actions towards a more sustainable and circular textile sector in the EU. The framework calls upon the member states and the actors of the textile value chain, to work towards its implementation.

The matter of the increasing consumption and rapid disposal of clothing is emphasized by the fact that the average household expenditure on clothing has increased by 30% in relation to inflation. The oversupply of clothes, combined with the reduced attention to their quality and durability in the design process have led to a decrease in garment prices. However, this has not resulted in a proportional benefit for consumers, as the clothes are often discarded quickly, leading to further consumption, (European Commission, 2022). The framework highlights the importance of sorting and recycling textiles, while further suggesting an alternative approach to addressing the issue of overconsumption.

In the framework, the Commission highlights the significance of improving product design, given that failures in zippers, tear strength, and colour fastness are among the most common reasons for clothing to be discarded. The proposed solution is to implement the mandatory fulfilment of Ecodesign requirements, which relate to product quality and durability, restrictions on hazardous chemicals, as well as the sourcing of fibres used in textile production.

3. METHOD

The research was conducted through a mixed-methods approach, incorporating different qualitative data collection methods. Further, the process includes a literature review and a semi-structured interview providing the qualitative data of this paper.

3.1. Conducting the Literature Review

The literature review was conducted using a systematic approach and aligned with the following steps to ensure quality was maintained throughout this process.

The first phase of the literature review revolved around defining the research questions. In this study the research questions were defined as the following:

What are the main circularity strategies in the fashion textile industry and what significance does textile recycling have in relation to them?

What optional channels and solutions are available for fashion retailers when it comes to textile recycling and how efficient are they when it comes to end-of-life textiles?

The next step was to identify relevant databases and search terms. The databases used for this study was Web of Science, Google Scholar, and Scopus. This part of the method was to gather all the quantitative data to conduct this research. The search terms used were "textile recycling," "end-of-life textiles," "sustainability," "supply chain," "fashion retail," "circular economy," "challenges," "opportunities," and "solutions." The literature review focused on peer-reviewed articles, company reports, and books that were related to the research topic.

After the establishment of relevant databases and search terms, the search could be conducted. This part of the research involved a comprehensive review of existing literature and legislative documents, to gain an understanding of the social and legislative drivers of circularity and longevity of textiles in the fashion retail industry.

Once the search results were gathered, they were reviewed to identify relevant articles that met the inclusion criteria of this study. The inclusion criteria for the literature review were that the articles should be published in English, be peer-reviewed, and contain information related to the research topic. After most of the relevant articles had been identified, the next step was to extract the most relevant information that was aligned with this report. This information included the challenges, opportunities and solutions related to textile recycling from a fashion retailer perspective. Once the extraction process had taken place it was time to analyse the data. This was to identify themes in relation to the research questions.

3.2. Selection of Empirical Examples

The choice was made to include empirical examples which discuss measures that have been put in practice to achieve circularity among fashion retailers. Examples on this topic relates to the second out of the two research questions. Nudie Jeans and H&M are both regarded as "fashion firms" according to Stål & Jansson in Sustainable Development (2017), which aligns with what is explicitly defined as "fashion retailers", in the research question.

Although both companies operate in the fashion retail industry, Stål & Jansson (2017) state that H&M is for a fact rather regarded as an integrated retail chain, than a single brand as Nudie Jeans is, which is established through the revenue of 223 553 MSEK during the year of 2022 (H&M Group, 2022). In relation to Nudie Jeans, which had a revenue of 483 MSEK

during 2021, this difference distinguishes the separation between the two brands as one being a global integrated retail chain, and the other being a single brand. This was a conscious choice, to illustrate circularity in different scales and business models.

Another reason for focusing in on H&M & Nudie jeans were that they had a lot of information available and were relevant to the research question. H&M is known for its fast fashion approach while Nudie Jeans focuses on sustainable and ethical production. This diversity allows for a more comprehensive analysis and a broader understanding of the subject matter.

3.3. Interview Methodology

For the semi-structured interview, subjective selection was used to select participants. The selection for the participant was done through handpicking what was thought to be the best candidate that we could reach in the short time span that was given to conduct this study. In the sense of “best”, the participant was chosen to have relevance with this field or possessing of knowledge that could be beneficial to this study. Although, several elements were taken into consideration such as the criteria that they should be working in the textile industry or have experience in textile recycling and be willing to participate in the study. The recruitment and arrangement of the interview was conducted through e-mail conversations, that ultimately led to a final meeting online since the participant preferred to be interviewed remotely, rather than in person.

3.3.1. Interview Structure and Layout

The semi-structured interview was conducted online with the participant, and the duration of the interview was approximately 60 minutes. The interview was recorded and transcribed verbatim. The interview questions were developed based on the research questions and the literature review. The questions were open-ended, and the participants were encouraged to provide detailed responses. The interview questions focused on the challenges, opportunities, and solutions related to textile recycling from an industry perspective.

3.3.2. Satin Project

The research questions posed in this thesis necessitated a methodology that would allow for exploration of circularity measures within the fashion industry. As a result, the research team became acquainted with the SATIN project, which served as an illustrative case study for textile recycling and circularity practices. The literature study provides a theoretical background to circularity and practices such as recycling.

The SATIN project provides a practical perspective on these strategies, and thus an opportunity to closely examine and analyse the functionality of these circular practices within the fashion industry. This led the research team to engage with the SATIN project, which serves as a compelling example of textile recycling and circularity practices.

Further, the SATIN project covers the perspective on textile recycling from a number of different stakeholders’ perspectives, such as the industry, textile manufacturers, and recycling facilities. The project was evaluated through studying the project end report, to build a theoretical basis. To broaden the knowledge into a holistic perspective, the formerly mentioned interview was conducted with an industry expert that participated in and led the project.

3.4. Ethical concerns

Informed consent was obtained from the participant before the semi structured interview was conducted. The participant was informed about the nature of our study, their rights as a participant and their right to withdraw at any time of the study. The participant expressed willingness to have her name published and therefore anonymity and confidentiality about the interviewed participant was not kept hidden.

Secondly, the literature review was conducted using peer-reviewed articles, publicly available journals, and books, as well as other available articles from prior mentioned databases. No personal information was obtained from individuals in the literature review part of this thesis. Therefore, there was no ethical concerns related to the data collection of this process.

Thirdly, the data obtained from the interview was transcribed through Microsoft's own transcription program and was stored securely to ensure confidentiality of the participant. To ensure the privacy of the participant information that could lead to identifying the participant was removed from the transcript. The transcript was also reviewed multiple times to ensure that identification of the participant could not be carried out, unless the name was explicitly mentioned. None of the questions addressed during the interview were linked to a specific company or party with a financial interest in the outcome of the thesis. It is therefore believed that the responses given by the participant was objective.

Lastly, the study was conducted in a way to ensure it was conducted with integrity and with respect to the participant. No conflicts of interest were detected prior to, during and or after the interview was conducted.

3.5. Limitations

The limitations of the study include the small sample size for the semi-structured interview. This was due to time limitation set for this thesis as well as target-people that were not responsive when it came to being interviewed. With this small sample size, it is most likely not representative of the fashion and textile industry. The data collected may therefore be limited to the participants individual experience and may also not reflect the different viewpoints within the field.

4. RESULTS

In this section of the report, the focal point will be to present empirical examples of circularity practices in the context of fast fashion, while further investigating the challenges and prospects of the specific circularity practice of textile recycling- including examples from the companies H&M and Nudie Jeans. The structure will follow an order that first presents literature findings that construct the empirical examples, while relying on findings based on an interview when investigating textile recycling.

4.1. Circularity in the context of fast fashion

This segment examines the circularity solutions that have been adopted by some of the global actors in the fast fashion industry. Research conducted by Dragomir et al (2022) shows that the big players in the textile industry have adapted complex systems to reduce their environmental impact by implementing strict rules that need to be maintained throughout their supply chain. Additionally, these corporations educate their suppliers within the subject that is circularity and promote recycling and reusing habits to their consumers. The approach used is focused on resources, not outputs, where resources can be redistributed in the supply chain. Where the redistribution should take place depends on the physical properties, available technologies, and the current consumer demands, (Dragomir & Dumitru, 2022).

4.1.1. Upstream activities

The circular economy model for the fashion industry encourages the use of recycled fibre in the upward stream of the supply chain instead of the more traditional input of virgin fibre. These fibres are then transferred to textile and clothing manufacturers which are usually not owned by the fashion retailer (Dragomir & Dumitru, 2022). This makes it extra important to have enforced international standards throughout the supply chain, for example ISO certifications, that clearly define the requirements for quality management systems, environmental management systems and other management systems. These practices should be enforced within the contracts to the respective supplier and subcontractor to ensure that standards are upheld. Although this is not a guarantee for compliance or quality. Some of the policies adopted by larger fashion companies such as H&M involve but are not limited to, the restriction of certain chemical substances, production waste through the entirety of the supply chain and water usage efficiency.

As mentioned by Dragomir et al (2022), outsourcing of the manufacturing process is quite common for fashion companies. Fashion companies should ensure they are using environmentally certified subcontractors as well as suppliers. What the fashion companies fully control are business procedures including designing, packaging, distribution, and retail. If large retailers can start collecting post-consumer waste, the recovery process for end-of-life textiles can begin.

4.1.2. Downstream activities

The downstream activities include customer use, product use as well as textile recovery. Textile recovery evolves around the collection process of end-of-life textiles to ensure they are recycled

or redistributed in other ways. In collaboration with non-governmental organisations this process can be carried out in an effective way.

One way to enable fashion retailers to recycle clothing is linked to the traceability of the garment, detailed labelling of the garment allows the recycling process to be carried out in a much more efficient manner. Not only is this beneficial for the recycling process, but it also allows for greater transparency for the customer and could act as a decisive for the consumer whether a purchase will be carried out or not, (Dragomir & Dumitru, 2022).

4.2. Circularity practices among fast fashion retailers: Exemplified by H&M

In the context of fashion retailers and businesses within the textile industry, the focal point is not only to recycle already consumed products, but also to scale down the consumption of various resources in the production process.

An example taken from the fashion retailer H&M group's sustainability report (2022), states the implementation of various business procedures to target the sustainability goals set for the decades to come. One of the procedures was launching their water strategy 2030, which framework was extracted from inputs from nongovernmental organisations, water experts and suppliers in respective region, (H&M Group Sustainability report, 2022). Previous procedures were aimed to improve water quality, efficiency in which water is used for the production process as well as growing the raw materials used for textiles at a facility level. Focus is now put onto reducing total water usage, this to reduce resource usage. This is one of the tasks that is greatly incorporated into their business procedures and aligns with their aim to move to a circular production model. H&M group are trying to align with the Ellen McArthur foundation view for sustainable fashion, where focus is put on products to be in use for longer time periods, where products are made to be made again and composed of renewable and sustainable materials. This further emphasizes that recycling is no longer the main goal of end-of-life textiles.

4.2.1 Durability

H&M group launched their very first denim collection designed for circularity, the collection was launched in alignment with the Ellen McArthur foundation Jeans Redesign guidelines, (H&M Group, 2022). Most companies tend to test the durability and performance of their clothing through various measures, since this is mostly done on individual basis, there has not been set any industry standard to measure this. Therefore, guidelines were developed by the Ellen McArthur foundation to work as a starting point for the industry to increase their durability practices. Durability has two aspects, physical durability, and emotional durability. Physical durability is how much force a garment can withstand, for example, how many times can it be washed without decolouring, how many times can it be worn without it tearing and so on. Emotional durability is the products ability to maintain relevancy for the user over a period. The guidelines in this case are set for denim, specifically jeans. Some of the points are that jeans can withstand a minimum of 30 home laundries, meaning they will still retain their durability after 30 washes. This as well as providing information for the consumer on things such as reducing washing frequency and washing at low temperatures to preserve the quality (Ellen McArthur foundation, 2021).

4.2.2. Extended use

H&M group focuses on three interconnected areas for this to come into fruition. Firstly, circular products, creating products that are made to last that come from sustainable and renewable materials. Secondly, circular supply chains where scalable systems are put into place to enable repairing, reusing, and recycling procedures. Lastly, circular customer journeys where H&M provides the consumer with easy ways to make sure their products stay in circulation for longer. The common denominator and core for these areas to function properly to reach the aim of clothes to stay longer in use, is the fact that they offer the repair and remake processes which aims to keep products in circulation for longer. The criteria for a product in a circular system, is that it is still usable and provides some kind of value to the consumer. To fulfil this criterion, products may need to be modified or repaired, which is emphasized as the key measure in the work towards circularity in the case of H&M (H&M Group, 2022).

4.2.3. Closing the loop

H&M is a prominent example of a fashion retailer that is utilising many parallel channels for end-of-life textiles. Since 2013 they have had global garment collecting program focusing on closing the loop, (H&M group, n.d.). With its Close the Loop effort, H&M hopes to improve resource efficiency and minimize waste in the fashion sector. The concept is centred on gathering used clothing from customers and repurposing it into new goods. There are various parts to the Close the Loop program. First, H&M invites shoppers to donate their gently used clothing to any H&M location, regardless of the brand. Next, the clothing is divided into three groups: re-wear, reuse, and recycling. The groups follow the specific order of re-wear, reuse and recycling where recycling is set as the last option. When clothing is still in good shape, it is either donated to a charity or sold on H&M's second-hand marketplace, Sellpy. Clothing that is not suitable for re-wearing or extended use is transformed into other goods like insulation or cleaning cloths. Lastly, garments that cannot be re-worn or get extended usage is turned into new fibres that can be utilized to make new clothing.

The Close the Loop program offers several advantages. H&M reduces the quantity of textile waste dumped in landfills by collecting worn clothing, this aids in resource conservation and lowers greenhouse gas emissions. By preserving materials and lowering the demand for virgin materials, the initiative also aids in the development of a circular economy for textiles. Additionally, by selling used goods and lowering the cost of raw materials, the program has the potential to bring in extra revenue for the company in the addition of already mentioned benefits.

4.2.4. Rental services & resale as a service (RAAS)

In 2019, H&M launched a rental service at one of their stores in Stockholm, Sweden, allowing customers to rent selected outfits from exclusive collections, providing them with an alternative to constantly buying new items. By offering rental services, the need for new products to be produced is reduced since consumers can rent directly on demand, while also extending the lifespan of garments that have already been produced.

Similarly, resale platforms offer fashion retailers another alternative channel to sell used or pre-owned clothing and garments. By doing so, the lifespan of textiles is extended, allowing a garment to be utilized over a longer period, ultimately reducing textile waste.

4.3. Incorporating value-added-services: Exemplified by Nudie Jeans

If in the production process producers can already establish some value-added service or incentive for consumers that makes them wear a garment for longer, the recycling process will become less important as garments will stay in circulation longer. Although consumer behaviour is difficult to analyse, this will allow positive sustainability to be manifested if done successfully.

The Swedish Clothing Brand *Nudie Jeans* has successfully incorporated such services in their offerings to the customer by utilising all stores into repair workshops, where customers can turn in their jeans for reparation, free of charge. Additionally, they offer a discount of 20% on a new pair of jeans when an old pair is turned in, the old pair is then repaired and resold in a physical store or online (Nudie Jeans, 2022).

According to Nudie Jeans' sustainability report (2022), the number of jeans collected, repaired, and sold through their repair shops is on a steady rise. During 2021, nearly 14 000 pair of jeans were collected through their repair shop, which is a 51% increase in comparison to the previous year of 2020.

Additional to the repair and return services provided by Nudie Jeans, the company also emphasizes the importance of an ethical fashion industry by providing their customers with transparency throughout the supply chain. The aim is to allow consumers to make informed choices based on this information. The customers are provided with information about textile suppliers, production processes, and material traceability (Nudie Jeans, 2022).

4.4. The SATIN project

The SATIN project as an initiative from the Nordic Innovation Offices (2022), aims to chart and evaluate the efficiency of the optional textile recycling channels in the Nordics. The end report presents the importance of collaboration, sustainable business models, technology, and consumer engagement, as key factors that have the power to influence the prospects of textile recycling. Not only do these factors help in reducing waste, but also in increasing resource efficiency, and creating a more sustainable textile industry. When exemplifying the need for collaboration, the project highlights the importance of collaboration between different stakeholders involved in the textile industry, including designers, manufacturers, suppliers, and retailers. Suggestions include collaboration on development and implementation of sustainable practices that benefit the environment and society. Further, The SATIN project identifies the importance of sustainable business models that focus on integrating social, economic, and environmental factors in order to reduce waste, increase resource efficiency, and create a more sustainable textile industry.

The role of technology is considered, and the report touches upon the potential of technology as a driver of innovation and sustainable practices in the textile industry. These technologies include blockchain, artificial intelligence, and 3D printing, which could in the correct application, increase transparency, reduce waste, and improve the overall efficiency of the

industry. The SATIN project also highlights the importance of engaging One key point in the report is the consumers role in sustainability practices. Increasing consumer awareness, while offering sustainable products and services, are pointed out as vital measures to shift into a more circular approach in the industry (Riikka Kaipia et al., 2022).

4.5. Interview on the SATIN project

In this section, the findings from the semi-structured interview with the senior researcher Linea Kjellsdotter Ivert, responsible for the SATIN project, will be presented. During the interview the following topics were discussed:

1. Logistics in the context of textile recycling
2. The complexity of textile recycling
3. The role of regulations and producer responsibility in order to mitigate a higher rate of recycled textiles in the EU
4. The complexity and challenges of textile collection
5. Textile recycling in the Nordics, particularly Linea's involvement in the SATIN project

4.5.1. The textile recycling process and stakeholders

During the interview the process of turning waste material into a new viable product in the context of trying to become more circular, was discussed.

One of the key issues lay in the fact that the material is widely spread geographically among the individuals or end-consuming companies. This highlights the significance of logistics in terms of mitigating textile recycling. The alternative when the logistics are malfunctioning, is to turn to less logistically complex alternatives- which is to use the garment for energy recovery purposes. In fact, in the Nordics, around 33% of our used textiles are being collected, and only 1% is being recycled. This fraction of the textiles is in most cases used to fill the purpose of downing or isolation for furniture.

Although it is important to keep in mind that most of the collected textiles are reused which, from a sustainability perspective, is a better alternative than recycling. Particularly looking at the waste ladder, waste should be prevented in the first place. However, a significant amount of textiles still go to waste due to the lack of efficient collection and processing channels. To further examine this, the SATIN project was initiated and conducted between the years of 2019 and 2022, with the aim to investigate the logistics around recycling of textiles in the Nordic region.

Regarding the textile recycling process, many collection companies participate, with non-profit organizations generally collecting large volumes of textiles. Other companies involved focus on upcycling by extracting materials to improve their use. Real estate companies also participate by providing a simplified drop-off process for their tenants, enabling multiple individuals to use the same collection point.

In addition to the formerly mentioned companies, our interviewee mentions other stakeholders like the municipality of Kungälv in the Gothenburg region also played a significant role in the project.

The municipality has a vital role since a significant amount of textile waste is typically generated in households. The municipality's perspective on this matter was distinct since their

focus was primarily on energy recycling. The collected garments' quality is typically low, which contributes to the accumulation of a significant amount of textile waste.

Among stakeholders in the industry, Nudie Jeans, known to be an environmentally conscious company, stands out as a noteworthy partner that prioritizes sustainability rather than engaging in greenwashing. They have built a business model centred around retaining customers and offering solutions for reconditioning jeans.

4.5.2. EU directives and extended producer responsibility

Notably, the topic of new EU directives was discussed as a vital measure to increase circularity and mitigate recycling. The directives, such as the extended producer responsibility, are expected to mandate separate collection of textiles to prevent their disposal as residual waste, thereby making recycling and waste management more established.

However, the implementation of these directives requires approval from approximately 25 member states. The implementation of this new directive implies that discarding textiles alongside other waste will no longer be allowed. Therefore, it must be collected separately to facilitate the recycling and waste management process.

This presents a significant challenge, and a thorough investigation was conducted to determine how to achieve this. The statistical findings on low recycling rates from the SATIN project, finds further support in a report on the responsibility of textile industry players to produce waste that was published at The Borås University of Textiles.

The report includes proposals on who should take responsibility, how it could be executed in Sweden, and the benefits of such a measure.

Nevertheless, it is highlighted in the discussion how the government has yet to decide. It appears likely that the EU will require extended producer responsibility (EPR) for textiles in all member countries, with producers collaborating to form an organization responsible for managing textile waste.

Elkretsen, is an example of EPR in practice, that is mentioned during the interview. This is a case of practical implementation of extended producer responsibility, where the outcome has been, per definition, successful. *Elkretsen* is a non-profit organization operating in the electricity industry in the Nordics, by collecting, transporting and recycling electronic products. The organization is collectively financed by several member companies that deploy these activities. The main incentive for this initiative is the requirements on producers taking responsibility, posed by the EU for producers within the electronics sector.

4.5.3. Challenges in collection process and recycling of textiles

The SATIN project uncovers a number of deficiencies and challenges in the collection and recycling of textiles.

During the interview, the lack of a centralized collection system and the coordination of varied logistics of different stakeholders, is highlighted. The collection of textiles is currently decentralized at the national level, with consumers and reselling platforms such as Blocket and Tradera, non-profit organizations, and retailers like Nudie Jeans and Lindex all operating their own logistics systems. This decentralization makes it difficult to scale up and synchronize the collection of textiles, particularly for larger volumes. Moreover, textiles are often of low quality and unsuitable for reuse, leading to a low collection rate of around 33%, with approximately

seventy-five thousand tons ending up in household waste each year. While the reuse rate is over 90%, most textiles are reused abroad.

To increase collection rates, our interviewee suggests that it is essential to make it easier for consumers to dispose of textiles, which means establishing collection points closer to individual households. However, the discussion also highlights the matter of increased costs for logistics and transportation, and it is unclear who will bear these costs. One potential solution is to leverage e-commerce platforms to collect textiles, with trucks that deliver goods collecting textiles for recycling. Additionally, there are exciting opportunities for recycling and reusing textiles, such as the growth of e-commerce platforms promoting textile reuse and the testing of collection systems through public living areas. Sorting textiles for recycling is challenging as well, as different materials need to be sorted into specific categories.

A growing issue discussed, is the fact that most textiles never go through the initial sorting at the end-consumers site, this can be seen in Figure 3 below. This poses an issue since it is one of the most labour-intensive parts of the textile recycling process. While this is difficult to achieve with a decentralized collection system, it is necessary to improve the reuse and recycling of textiles. Overall, the textile recycling industry needs to address issues around logistics, transportation, and sorting to improve collection rates and ensure that textiles are properly recycled and reused.

Given the significance of logistics in circular flows, and with the interviewee's insight in the occurring issues in implementing the circularity practices, logistics has arguably been neglected in the past, but there has been recent improvement. However, more processes are needed for pre-treatment to ensure that the material can be moved efficiently, as logistics is an important component of circular economy. Supply chain management is a broader concept that encompasses logistics, and it is important to coordinate actors to achieve circularity in various areas, such as textiles.

In conclusion, the circular flows present some challenges, particularly in the case of waste contractors who must make the best of what they receive without knowing the exact quality or volume. Balancing supply and demand are critical, and the low prices of used clothes and recycled materials make it difficult to compete against newly produced products. It is necessary to prevent waste in the first place by designing products and materials that can be reused, repaired, and remanufactured. Collection rates for textiles are low, and most of the waste ends up being incinerated even though over 50% of it could be reused or recycled. Designing for sustainability is challenging because it involves a trade-off between recyclability and durability.

5. DISCUSSION

The significance of the findings in this study further emphasises the importance of moving from the current linear model to a more circular model where products, in this case clothing, are made to be kept in circulation for longer.

One could argue that H&M's fast fashion business model encourages overconsumption and that the Close the Loop program is simply a way for H&M to continue producing more clothes while appearing to be sustainable. Others might argue that the program does not go far enough in addressing the root causes of textile waste, and that H&M should focus on reducing the amount of clothing produced in the first place.

Despite these concerns, H&M's Close the Loop program represents an important step towards creating a more circular fashion industry. By collecting used clothing and transforming it into new products, H&M is reducing waste and conserving resources. The program also has the potential to create new revenue streams for H&M, exemplifying the economic opportunities available in sustainability practices, and thus drive innovation in textile recycling technologies.

From a holistic perspective, the global textile system needs a shift of focus. In recent years, there has been a trend of ever-increasing consumption, and fashion that appears to only decrease in quality. This trend completely counteracts with the aim of becoming more circular. A new, circular model would include pillars such as a new business approach that strives to increase clothing usage, i.e., the number of times a garment is worn before it is disposed of. Secondly, there would be a need for safe and renewable materials that are made to last, a business revolving around the quality of the garments, rather than the fast output of quantity clothing. To achieve this, regulations need to be put into actions, with clear requirements of the producers to align with this approach- and design garments that will last. The EU's Mandatory Design directive, is one of the measures that has been undertaken on a government level, and it does fulfil the aim of regulating the most vital aspects of design, such as regulating the design practices in order to mitigate the recycling of the garment.

Considering the increasing issue with mixed-material textiles, the Mandatory Ecodesign Requirements entering into force, could arguably simplify the recycling process as well. This would take place by forcing the producer to practice full transparency in their statements on the composition of their materials, and thus simplifying the sorting process in before the recycling.

Lastly solutions for used clothes are needed, with the aim that old clothes will be easily turned into new ones. To fully enable such a system to be put into place, it would need to have a few certain characteristics. The system would need to provide customers with accessibility to high quality clothing that they may not previously have been able to get their hands on. It would have to give more flexibility in what type of clothing that is provided, perhaps through other channels than the traditional online and retail stores.

The study found that circularity in the fashion textile industry is a complex issue that requires a combination of strategies beyond just textile recycling, such as designing for circularity, extending the lifespan of textiles, and reducing waste in production. The significance of textile recycling in relation to other circularity strategies is highly dependent on several factors, including the quality of recycled fibres, the availability of suitable recycling technologies, and

the demand for recycled products. The study also revealed that there are various challenges and opportunities associated with textile recycling, including issues related to collection, sorting, and processing, as well as potential benefits in terms of resource conservation and reducing environmental impact.

Although textile recycling is often the circularity practice that catches the most attention, there is evidence in terms of support from both the 10R-model and the EU Waste Hierarchy that concludes the importance of the other strategies that aim to prevent the waste from even occurring, in first hand. This speaks for the optimistic fact that new innovations and completely different business models are a secondary solution. To align with the hierarchy of different circularity practices, there is an urgent need of interaction between the businesses within the fashion textile industry, and their customers. Referring to the circularity practices and the importance of preventing waste creation, this is arguably at least as important as establishing logistical systems to collect and sort end-of-life textiles. Not only is the waste prevention beneficial for environmental and sustainability reasons, but there is also financial interest in decreasing the amount of area that functions as landfills.

In terms of the textile recycling, the interview with the industry expert, supported by the analysis made on Nudie Jeans and H&M's sustainability practices, provided valuable takeaways in terms of identifying several optional channels and solutions being used by fashion retailers to achieve circularity. Such as rental and resale platforms, take-back schemes, and product innovation. The efficiency and effectiveness of these solutions vary depending on the specific context, such as the type of product, consumer behaviour, and the level of industry collaboration. This study also highlighted the need for a more systematic and comprehensive approach to circularity among fashion retailers, including the importance of setting clear targets and metrics, engaging with stakeholders across the supply chain and embracing a long-term vision of sustainability.

5.1. Ongoing development in textile circularity

The recent activities and progress in the field of textile circularity was studied by a recent Nordic research project and an expert interview. The SATIN project sheds light on several deficiencies and challenges in the collection and recycling of textiles, which have implications for achieving circularity in the fashion industry. The decentralized nature of textile collection at the national level, with various stakeholders operating their own logistics systems, hinders scalability and synchronization of collection efforts, especially for larger volumes. Additionally, the low quality of textiles often makes them unsuitable for reuse, resulting in a collection rate of only around 33%, with a significant amount ending up in household waste each year.

To address these challenges and increase collection rates, it is crucial to make textile disposal more convenient for consumers. This could involve establishing collection points closer to households or leveraging e-commerce platforms and delivery trucks to collect textiles for recycling. However, the associated costs of logistics and transportation need to be considered and allocated appropriately.

The sorting of textiles for recycling poses another challenge, as different materials require specific categorization. Currently, most textiles do not go through the initial sorting at the end-consumer level, which is a labour-intensive process. Improving the reuse and recycling of textiles necessitates addressing these logistical and sorting issues.

Balancing supply and demand are a critical consideration, as waste contractors must work with what they receive without knowing the exact quality or volume. The low prices of used clothes and recycled materials make it challenging to compete against newly produced products. To address these challenges, waste prevention should be prioritized through the design of products and materials that can be reused, repaired, and remanufactured.

The study further emphasizes the need for a systematic and comprehensive approach to circularity among fashion retailers. Clear targets, metrics, stakeholder engagement, and a long-term vision of sustainability are essential to drive meaningful change throughout the supply chain.

5.2 Method Discussion

The chosen methodology for this thesis involved a literature review combined with a single semi-structured interview. This approach was chosen to provide a comprehensive understanding of the research topic, drawing upon existing knowledge while also incorporating firsthand insights from a key informant. The literature review served as a foundation for this study by examining and synthesizing relevant scholarly works. It involved a search of peer-reviewed articles and other reputable sources, focusing on theories, concepts and empirical studies related to the research questions.

The inclusion of a semi-structured interview added a qualitative dimension to the research methodology, allowing for a deeper exploration of the research topic from the perspective of an expert in the field. The participant for the interview was purposely selected based on the expertise and experience within the field, ensuring that the insights would significantly contribute to the study. It followed a predetermined set of open-ended questions while allowing the participant to be flexible as well as elaborating further on their responses. This approach enabled the researcher to delve into specific areas of interest and gain rich and detailed information.

The integration of the literature review and the semi-structured interview allowed for a triangulation of data sources, enhancing the validity and reliability of the findings. The literature review provided a broader context and main theoretical framework, while the interview added depth and nuance through firsthand accounts and expert opinions. This combination of methods enabled a comprehensive exploration of the research question.

After analysing the method section of this paper, the subjective selection method used for the participant selection in the qualitative data collection process of this paper seems to be the most adequate measure. The subjective selection approach was made since it was believed this participant would give the most relevant of information and insight into this topic. This was thought to be a more suitable choice of method for this section, than if the participant was chosen through a random or systematic approach.

It is important to acknowledge the subjective judgement as it can be ground for bias and interfere with validity and generalisation of findings in this study. To minimise bias, one could have used random sampling or stratified sampling. However, when conducting research such as this, subjective selection can be appropriate or even necessary. This since when studying a specific topic, some individuals may be more knowledgeable and experienced than others.

The benefits of using literature review for extracting quantitative data is that there is access to large amount of existing knowledge. The literature review can also increase the accuracy of the

study by providing a systematic and comprehensive overview of the existing research on a topic. It also gives access to different perspectives on the topic and how to tackle certain issues from different angles.

The drawbacks of this are that it is limited to existing data. Another important factor to note is that is limited to published sources. Internal material that could have proved insightful and meaningful to this study have not been obtained.

However, it is important to acknowledge some of the limitations of the chosen methodology. The use of a single semi-structured interview may limit the generalizability of the findings, as it only represents the perspective of one participant. Additionally, while the literature review was comprehensive, it is possible that some relevant sources may have been missed or omitted, due to time limitations and to not strive too far away from the core of this study. Future studies could consider incorporating a larger sample size and evaluating other stakeholders than the ones in this study. Further research could also utilize other qualitative research methods, such as focus groups or case studies, to further enrich the findings. Despite some limitations, this methodology offers valuable insights and lays some groundwork for further research in the field.

6. CONCLUSION

The study highlights the significance of circularity strategies such as closed-loop production, recycling, upcycling, and reusing textiles. While initiatives such as H&M's Close the Loop program can be seen as positive steps, they may not go far enough in addressing the root causes of textile waste. To further achieve circularity in the textile industry, businesses will need alter their business practices and move away from the fast fashion business model of today.

To achieve a circular model in the fashion industry, there needs to be a focus on increasing clothing usage, using safe and renewable materials that are made to last, and regulations that incentivize producers to design garments that will last. The EU's Mandatory Ecodesign directive is one example of a regulation that aims to mitigate textile waste by regulating design practices. Additionally, the directive could simplify the recycling process by enforcing full transparency in the statements on material composition. This will also address the current challenges related to mixed-material textiles and further simplify the recycling process.

The study also reveals deficiencies and challenges in the collection and recycling of textiles, including the lack of a centralized collection system, coordination among stakeholders, low collection rates, and difficulties in sorting textiles for recycling. This highlights the need to establish collection points closer to households, leverage e-commerce platforms, and improve logistics and transportation to enhance the lacking collection rates and ensure proper recycling and reuse of textiles. Logistics and supply chain management play significant roles in achieving circularity in the textile industry. Coordinating actors, balancing supply and demand, and addressing the trade-off between recyclability and durability are critical aspects that need to be addressed.

Collection stations for end-of-life textiles need to be established and allocated closer to the consumers. By having collection stations located in proximity to consumers, it becomes easier and more convenient for them to dispose of their used textiles. The convenience factor also encourages participation for the consumers allowing for higher collection rates. This is since when collection points are distant or inconvenient, consumers may choose to discard their textiles in regular waste streams.

The findings of this research show that textile recycling can be significant in achieving circularity in the fashion industry, but that there are other options that can be better, such as focusing on extending the usage and life cycle of a garment. The current linear model is not sustainable enough and the fashion industry need to shift towards a more circular model, where products are designed to be kept in circulation for longer, and where there is a focus on safe and renewable materials that are made to last. This includes designing for durability, where focus is on creating garments and textiles using high quality materials, durable construction techniques and timeless designs in order to increase the lifespan of products. By promoting durability, the fashion industry will aim to reduce the frequency of purchasing new items. Other approaches such as designing for recyclability and conversion of old or discarded textiles into new textile products, are also important strategies.

Lastly, to fully enable a circular system to be put into place, solutions for used clothes are needed that allow for old clothes to be easily turned into new ones. This would require a system that provides customers with accessibility to high-quality clothing and more flexibility in the

types of clothing available. Textile recycling plays a significant role in supporting these circularity strategies but should not be the main or only approach the industry takes towards achieving circularity.

6.1 Recommendations for further research

With this thesis providing a background in the multifaceted aspects of circularity within the fashion industry, this section presents several suggestions for future research.

Firstly, it is necessary to investigate the challenges and opportunities associated with circularity from the perspective of various stakeholders, including consumers, producers, policymakers, and non-governmental organizations. Conducting this in a more detailed manner and gaining a deeper understanding of their roles, responsibilities, and potential collaborations will shed light on the collective actions needed to realize sustainable and circular practices in the fashion industry.

Secondly, the potential of emerging technologies, including AI, in relation to circular practices is one possible field of research that needs an update. In practice, this could be done by investigating the connection between these technologies and streamlining supply chains, enhancing traceability, and promoting circularity on a broader scale in the fashion industry.

Lastly, it is of foremost importance to further analyze the regulatory frameworks on the topics of sustainability and circularity. The regulatory frameworks are in fact pointed out as the most effective measures, on an industrial level, towards sustainability in the fashion industry. Further research in the area could shed light on potential gaps or areas for improvement on existing and upcoming framework.

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