Master's thesis

NTNU
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Department of Mechanical and Industrial Engineering

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Logistics and Supply Chain in Circular Economy and Several Solutions for Norwegian Personal Clothing

Analyzing and Mapping Norway's Private (Personal) Clothing: Applying Circular Economy Principles, A Logistics Perspective on Current Practices and Improvements.

Master's thesis in Global Manufacturing Management
Supervisor: Jan Ola Strandhagen
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Acknowledgment

This master's thesis is the completion of my academic career in the Master of Science degree in Global Manufacturing Management at the Department of Mechanical and Industrial Engineering, Norwegian University of Science and Technology (NTNU). The process of completing my thesis has been a very informative and enriching experience, equipping me with valuable information and abilities that I will continue to use after the completion of this significant project.

First and foremost, I would like to express my sincere appreciation to my supervisor at NTNU, Jan Ola Strandhagen, for his important mentorship, insightful counsel, and unfailing assistance during the semester. The individual's critical critique and perceptive recommendations have significantly enhanced my study, giving me a more profound comprehension and a more lucid viewpoint on the topic. I am very grateful for his guidance and the time he dedicated to supporting my intellectual development.

I would want to extend my heartfelt gratitude to my friends, who have consistently provided me with unwavering support and encouragement during this arduous but fulfilling endeavor. Their comprehension, camaraderie, and confidence in my capabilities have served as a significant catalyst, enabling me to successfully negotiate the intricacies of this endeavor with unwavering perseverance and resolve.

This thesis serves as evidence of the joint endeavor and shared knowledge provided by my supervisor and friends. I express my gratitude for each and every contribution that has influenced and molded my learning experience and this research endeavor.

Kobra Norouzi

January 2024

Abstract

In order to address the growing worldwide issue of resource depletion and environmental effects, this thesis investigates the crucial shift that Norway's private clothing system are making towards a circular economy. Since the garment sector is a big consumer of resources and a contributor to emissions of greenhouse gases, there is an immediate need to reevaluate and redefine the methods that are now in place. Specifically, the study investigates the complex nature of this shift, which encompasses consumer behavior, waste management, and the logistical issues inherent in establishing a sustainable circular system.

At the beginning of the research, a complete picture of Norway's present clothing consumption patterns is painted. This comprehensive image highlights the high per capita use of clothes as well as the large amount of clothing waste that results from this usage. This highlights the need to make a paradigm shift away from the prevalent linear model of "take-make-use-dispose" and towards a more environmentally friendly circular framework. To do this, it is necessary not only to reduce the amount of trash produced but also to maximize garments' usage and life cycle by using creative recycling and reuse techniques.

One of the most critical aspects of this study is the investigation of the difficulties that are associated with logistics, specifically with the effective collection, sorting, and processing of textile waste within the context of Norway's distinct geographical and demographic characteristics. The research proposes strategic methods to develop more efficient collection systems, increase consumer engagement via incentives, and foster cooperation among stakeholders, such as government agencies, industry actors, and the general public.

In addition, the thesis discusses the significant role that consumer behavior and public knowledge play in pushing the move toward circularity. The organization promotes the implementation of focused educational and awareness initiatives to alter consumers' behaviors and perceptions. These efforts should emphasize the significance of responsible clothes disposal and adopting circular consumption patterns.

The solutions that have been presented have the goal of not only ensuring the preservation of the environment but also generating economic prospects using the formation of new environmentally responsible behaviors and enterprises. Within the framework of the sustainable and circular apparel industry goal, this thesis functions as a fundamental research, providing insights and methods relevant not just to Norway but also to the larger global context.

In conclusion, the study offers a comprehensive analysis and a strategic framework to modernize Norway's apparel system. Not only does this transformation have the ability to alleviate environmental problems, but it also has the potential to generate economic development and innovation. The results highlight the potential advantages of this transition. To reach the full potential of a circular garment economy, the route ahead needs ongoing research, the improvement of technology, and the creation of legislation.

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1 Introduction

This section illustrates this thesis's background and motivation and explains the research's reasons. The following discussion will be around this project's problem statement, objectives, and scope. Additionally, a broad overview outlining the structural design of the thesis will be presented.

1.1 Background and Motivation

With resource demand rising rapidly, manufacturing companies face an increasingly critical challenge due to global resource scarcity (Michael Lieder, 2016). This uncertainty about resource supplies places these manufacturing companies in a difficult position. (Wong, 2010)
The clothing industry stands out as one of the most significant consumers of resources. (Strategy for Textiles, 2023). Fabrics come in fourth place after food, housing, and transport when using many raw materials and water with 79 billion cubic meters of water ; the clothing industry ranks fifth for greenhouse gas emissions with producing 1,715 million tons of CO2 emissions . (Raimund Bleischwitz*, 2022) In addition, the clothing industry holds a significant position in global commerce generating a substantial revenue of USD 1.3 trillion and employing about 300 million individuals throughout its value chain. Furthermore, based on the information reported by Fashion and Circular Economy, there has been a significant increase in textiles usage, particularly clothes, which accounts for 60% of the textiles used over the past 15 years. (Fashion and the circular economy – deep dive, 2023)
However, the current system for linear clothing supply chain predominantly relies on non-renewable resources (Mariarosaria Lombardi, 2023). In addition, the production process, from the introduction of textiles onward, necessitates extensive water, energy, and chemical resource consumption. Unfortunately, this resource-intensive approach produces substantial pollution, severely impacting the environment. Table 1 provides a comprehensive overview, delineating the specific challenges encountered at each stage of clothes production. These challenges encompass various environmental and sustainability issues that are prevalent throughout the clothing manufacturing process. (Reet Aus1*, 2021)

Table 1: Overview of the impact of each stage of clothing on the environment (Mariarosaria Lombardi, 2023)

Environmental problems	**The most impactful stages in product life cycle**
Energy consumption	Production of man-made fibers, yarn manufacturing, finishing processes, the washing and drying of clothes in the use phase
Water and chemicals consumption	fiber growth, wet pre-treatment, dyeing, finishing and laundry
Solid waste	Mainly the disposal of products at the end of their life, textile/clothing manufacturing
Direct CO_2 emissions	Transportation within globally dispersed supply chains

The European Union's textile industry produces approximately 16 million tonnes of textile waste each year, generating substantial waste. (Reet Aus1*, 2021) Regarding this, the European Union (EU), as a pioneer of a broader circular economy initiative, the Commission implemented an extensive EU strategy for textiles on March 30, 2022. This strategy targets sustainability, circularity, industrial competitiveness, and innovation within the textile sector. (Strategy for Textiles, 2023)

While Norway is not a member of the EU, it maintains its status as a member of the European Free Trade Association (EFTA). It has entered into an agreement with the EU known as the European Economic Area (EEA). Due to its participation in the EEA, Norway is obligated to implement EU directives within the environmental policy domain, as the Organization for Economic Cooperation and Development (OECD) specified in 2011 (Kjær, Municipal waste management in Norway, 2013). This emphasizes the importance of having policies that aim to reduce pollution.

According to findings from the Circularity Gap Report, Norway exhibits one of the highest per capita rates of material consumption on a global scale, estimated at a substantial 235 million tons annually. (The Circularity Gap Report Norway, 2020) As shown in Figure 1, each Norwegian generates 799 kg of waste, and it is the second largest waste producing per capita. (Statista, 2023) Moreover, the population in Norway is increasing, which forecasts an increase in consumption in the future as shown in Figure 2.

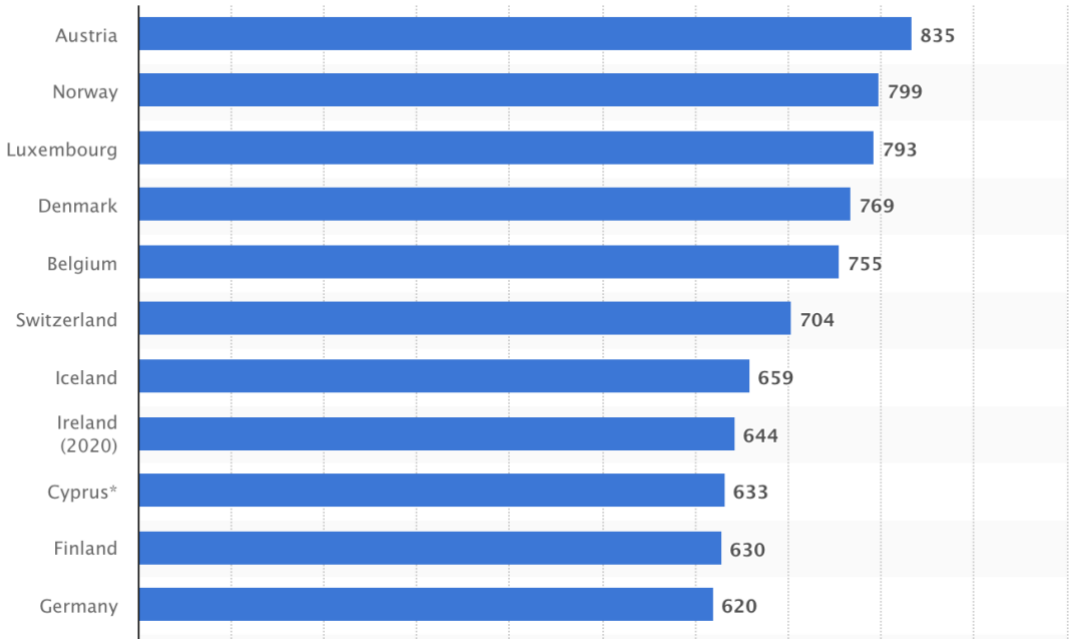

Figure 1: Per capita municipal waste generation in Europe in 2021, by select country (Statista, 2023)

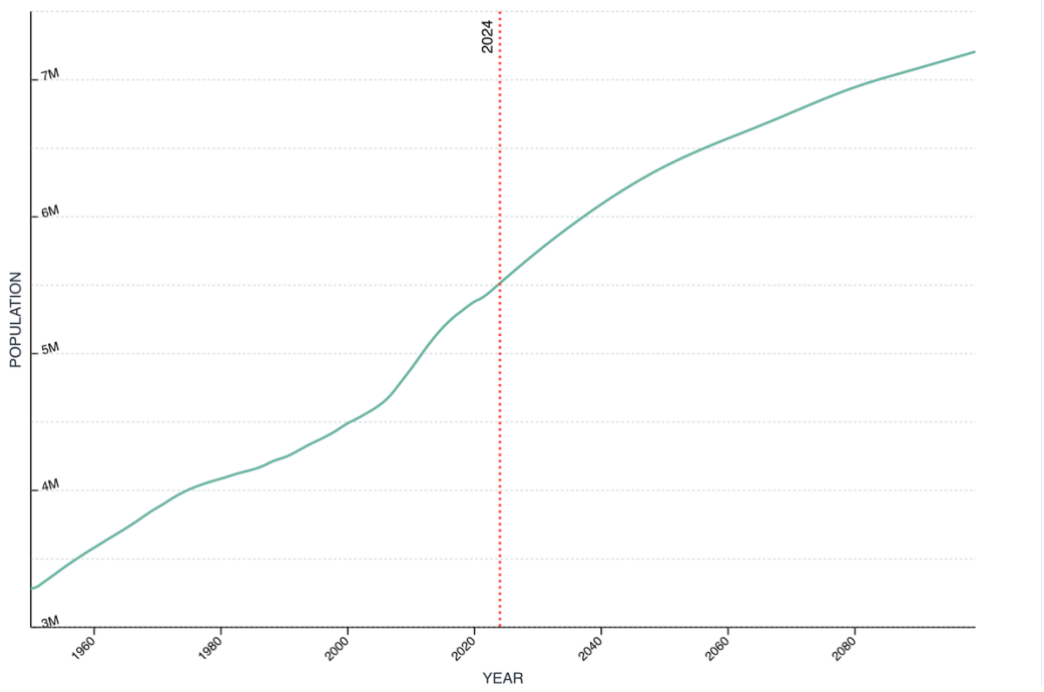

Figure 2:Norway Population (Review, 2024)

On the one hand, based on Ref (Camilla Sunde, 2023) the annual consumption of clothes in Norway equals 105,913 tones annually. According to this report, the total textile waste was

78,193 tons in 2022. This ongoing rise in raw material consumption, especially in the textile industry, poses concerning implications. This escalating consumption adversely impacts the environment by escalating greenhouse gas emissions, amplifying solid waste production, and expanding landfills. (Michael Lieder, 2016)

However, the environmental concerns associated with increased consumption are just one facet of a more significant issue. The continuous expansion of the global population is a significant factor contributing to future resource scarcity. This demographic growth will likely result in heightened competition for limited resources, exacerbating the challenge of resource availability. (Commision, 2014) Continuing with the prevailing linear economic model would necessitate the daily extraction of more raw materials, leading to increased pollution. The linear economy, characterized by a 'take-make-use-dispose' pattern, perpetuates this cycle of resource depletion and environmental harm. (Michael Lieder, 2016)

Adopting a circular economy framework is a viable solution to these multifaceted challenges. This approach focuses on reusing and repurposing materials through innovative methods such as reuse and recycling. Transitioning towards a circular economy model could mitigate the environmental impacts of excessive resource consumption. (Julian Kirchherr, Conceptualizing the circular economy: An analysis of 114 definitions. Resources, conservation and recycling, 2017)

In this thesis, we aim to tackle the issues prevalent in the personal clothing production sector by scrutinizing it through the circular economy lens. We strive to provide a comprehensive solution for clothing waste in Norway towards a circularized system that minimizes resource wastage and environmental harm.

1.2 Problem Statement and Objectives

Problem Description:

A multifaceted landscape of challenges has emerged as a formidable hurdle in pursuing the transformation of Norway's clothing system into a circular system. With its population of approximately 5 million individuals, Norway faces a unique set of circumstances and complexities as it endeavors to embark on this ambitious journey towards circularity.

One of Norway's distinctive features is its high per capita clothing consumption. While this reflects the affluence and consumer culture within the country, it simultaneously exacerbates

the challenges associated with transitioning to a circular model. The substantial volume of clothing consumption implies a correspondingly substantial volume of clothing waste that needs to be managed sustainably and environmentally responsibly.

However, collecting, sorting, and effectively redirecting this clothing waste back into the production cycle entails significant financial investments. The costs associated with collection, transportation, separation, refurbishment, recycling, and sale of used clothing present a substantial financial burden. To move towards circularity, there is a need for strategic financial planning and investment, which must consider the economic feasibility and sustainability of the entire process.

In addition to economic challenges, various logistical, infrastructural, and behavioral obstacles must be addressed. The logistics of efficiently collecting clothing from a dispersed population, ensuring effective sorting and quality control, and coordinating the return of textiles to the production cycle pose intricate challenges. Furthermore, raising public awareness and changing consumer behavior to encourage responsible clothing disposal and circular consumption practices is an ongoing endeavor.

Additionally, the circular economy within the clothing industry faces the dilemma of aligning itself with global production and consumption patterns while maintaining a localized and sustainable approach. The need to balance importing clothing and domestically managing its end-of-life cycle introduces supply chain dynamics, trade-offs, and resource allocation complexities.

Moreover, challenges in regulation, policy frameworks, and industry standards also need to be addressed. Establishing clear guidelines and incentives for businesses to adopt circular practices and ensuring that the legal framework supports the transition are critical steps in overcoming these hurdles.

In summary, Norway's journey towards a circular clothing system is marked by a complex interplay of economic, logistical, behavioral, and regulatory challenges. Identifying and understanding these challenges represents a pivotal first step in developing effective strategies and solutions to facilitate the transition. It is a multifaceted endeavor that necessitates collaboration among government bodies, industry stakeholders, and the public to pave the way for a more sustainable and circular future in the clothing industry.

Thesis Objectives:

The objectives of this thesis encompass two fundamental dimensions:

1- Comprehensive Mapping of the Norwegian Clothing System: The primary objective is to meticulously delineate the entire lifecycle of the Norwegian clothing system, commencing from production and sales to ultimate consumer consumption. This will provide a holistic view of the system, including its existing infrastructure and intricacies.
2- Evaluating the Viability of Circular Transition: After a thorough understanding of the current system and its infrastructure, an in-depth analysis will be conducted to assess the potential for transitioning towards a circular model. The evaluation will consider the compatibility and likelihood of aligning with circular economy principles based on the existing system and infrastructure.

By addressing these objectives, this thesis provides a comprehensive view of the challenges within the Norwegian clothing system and presents approachable solutions. This approach facilitates the assessment of its readiness and potential for transitioning to a circular model. Norwegian clothing system's challenges and approachable solutions, thereby facilitating assessing its readiness and potential for transitioning to a circular model.

1.3 Research Scope

This research investigates the challenges and opportunities of transitioning the Norwegian personal clothing system into a circular model. The scope of the study encompasses a multifaceted approach consisting of the following key elements:

Geographical scope: The geographical scope of this thesis revolves around Norway, with a specific focus on organizations exhibiting significant activity within Trondheim.

Group of Clothing: Our investigation within the clothing system narrows its focus to personal clothing , and it does not include other types of clothes such as uniforms, sheets, and curtains used in homes or hotels. Personal clothing includes the various types of clothes and fabrics utilized in daily life, particularly those consumed by the general population in Norway such as T-shirts, pants, etc. "*Clothing means all human-wearing apparel suitable for general use. "Clothing" includes, but is not limited to, aprons, household and shop, and athletic supporters.*" (Personal clothing definition, n.d.)

Actors and Responsibilities: An integral aspect of this research involves identifying and delineating the actors involved in the clothing system. We will ascertain which stakeholders

play a role in the transition towards circularity, outlining their respective responsibilities and contributions to the circular clothing ecosystem. This comprehensive examination aims to provide an understanding of the roles and responsibilities within the system. In addition to these specific elements, the research will continue to investigate the existing obstacles, evaluate the potential for transitioning to a circular model, and offer recommendations for enhancing circularity within the Norwegian clothing system. The study aims to provide a holistic view of Norway's challenges and opportunities in achieving a circular clothing system.

1.4 Research Questions:

To fulfill the objectives of this thesis, the following research questions have been formulated for investigation:

1- **How does the Norwegian personal clothing system work, and does it align with circular principles?**

This question aims to provide a comprehensive understanding of the adherence of the clothing supply chain in Norway to circular economy principles. It draws upon the findings obtained through the review of public reports.

2- **What are the prevailing challenges within the current system?**

This research endeavors to identify specific obstacles that impede the implementation of a take-back scheme within the Norwegian clothing system. This inquiry builds upon the insights gained from the review of public reports and the literature study.

3- **What strategies can be employed for system improvement in circularity ?**

The study aims to reveal the potential for transitioning Norway's clothing system to a circular economy, contingent upon successfully mitigating the identified obstacles. This exploration further builds upon the findings derived from the literature study.

The methodology utilized to address these research questions is elucidated in Section 2.

1.5 Thesis Structure

This section of the thesis provides an overview of the thesis structure, which is presented in the form of a thorough table below.

Table 2: Thesis Structure

Section	Description
Section 1: Introduction	The introduction of the thesis provides a comprehensive foundation for the research. Background and motivation come first, then the research objectives and questions, which direct the focus and direction of the investigation and the research scope. The introduction concludes with an overview of the thesis structure.
Section 2: Methodology	The methodology chapter presents the selected research strategy and details the research methodologies used, including literature study, data collection study, and material flow analysis.
Section 3: Theoretical Background	This section presents an overview of the main theoretical approaches that are applicable for addressing the research issues that have been stated.
Section 4: Personal Clothing system in Norway	This section discusses the personal clothing system in Norway, with a specific emphasis on consumption patterns and the process of collecting clothes. The text provides a comprehensive account of quantities of clothes used in domestic residences and describes the organizations responsible for collecting these clothes.
Section 5: Solutions for circular waste handling for clothes in other countries and another type of household waste in Norway	This section describes clothing waste management techniques in other countries and then describes Norway's approach to managing household waste. The aim is to identify possible improvements for clothes collection based on worldwide patterns and existing solutions in Norway for household waste.

Section 6: **Result and Discussion**	In this section, carefully review the knowledge gained from part 4, critically analyzing the accuracy of these discoveries concerning the established theoretical framework. The objective is to explore several strategies for integrating a Circular Economy (CE) model into Norway's private apparel sector, emphasizing the merits and drawbacks of each suggested option. This study seeks to combine actual observations with academic knowledge, providing a holistic view of improving sustainability in the garment sector.
Section 7: Limitations and Further Work	This section describes the study's limitations and suggests areas for future research, highlighting potential for further development based on the existing results.
Section 8: Conclusion	The conclusion summarized the main discoveries from sections 4 and 6, providing an overall review of the thesis's key arguments and outcomes.

2 Methodology

This section provides the proposed methodologies used to understand the existing challenges, analyze them, and offer a solution. The methods used in the research include literature review, data collection through reading public data, and material flow analyses, which are explained below, elucidating how each is utilized in the research.

2.1 Literature Study

A thorough literature review is fundamental for a comprehensive understanding of the research's concepts, facilitating the formulation of a precise research problem for the thesis. A literature review involves an extensive systematic exploration of existing research and theory within the Bumeister (R.F. Baumeister, 1997), aiding in getting familiar with the research and finding research gaps.

In this study, the words and areas of research were categorized into three distinct groups for a systematic exploration and analysis of the subject matter. Main and additional research terms were assigned for each main area, contributing to finding more accurate and valuable content. These categories encompass the domains of:

Circular Economy: This part involves an in-depth investigation into the principles, strategies, and practices of the circular economy framework.

Supply Chain and Logistics: This section reviews the supply chain mechanisms, logistics, and related practices within the circular economy context.

Fashion and Textiles: This category encompasses a detailed exploration of the fashion industry's textile manufacturing under the concept of circular economy.

By dividing the research into these three groups, a comprehensive understanding of the interplay between circular economy principles, supply chain dynamics, and the fashion industry's impact on sustainability initiatives can be achieved. An overview of the research is presented in the table below.

Table 3: Keywords used for research

Area of research	Main search words	Additional search words
Circular economy	Circular Cconomy Textile and Faison Waste management	Definition Advantages Challenges Concepts Elements
Textile and Faison	Household cloth Waste Handling Re-use Recycling	Challenges Norway Nordics Other Countries Consumption rate
Supply Chain and Logistics	Closed-loop Supply Chains Linear Supply Chain Logistics Green Logistics	Definition Challenges Elements Different Changes

To find relevant articles, a comprehensive exploration was conducted using academic databases such as Google Scholar, ResearchGate, and ScienceDirect. This process involved a search within these platforms, with results filtered based on their titles to identify articles aligned with the research's subject matter. Following this initial screening, the abstracts of the selected papers were carefully reviewed to determine their relevance to the research topic. Articles that were closely related to the study's focus were then chosen for detailed reading. Moreover, a snowballing technique was used where a selected article referencing another relevant publication led to further exploration during the literature study. (Ridley, 2012)

Two essential methods used in research are data collection and material flow analysis, which produce the primary data and understanding of the clothing collection process in Norway.

The literature review was instrumental in supporting the outcomes of data collection and material flow analyses, identifying crucial theoretical viewpoints, and establishing the fundamental basis for the thesis.

2.2 Data Collection

Data collection was employed to understand the clothing material flow processes in Norway. This methodological process involves gathering information about a specific subject.

Data collection involves two primary methods: (Bhat, 2023)

1. **Primary Data Collection:** This method consists of obtaining data directly from research activities, such as conducting surveys, interviews, or experiments to gather firsthand information.
2. **Secondary Data Collection:** Secondary data collection involves utilizing information gathered by others, typically available on websites or from previously published sources. It is crucial to ensure the credibility and reliability of these sources by verifying their authenticity and checking the documentation.

In analyzing Norway's clothing consumption and waste management systems, the research predominantly relied on secondary data collection methodologies.

This process commenced with a meticulously crafted and comprehensive Google search using specific keywords related to the subject matter, like clothing usage in Norway.

Following this step, an in-depth exploration of detailed reports sourced from esteemed and trustworthy platforms such as Afvall Norge and Etisk Handel Norge became the cornerstone of the investigation. These reports were instrumental in providing an extensive overview of the prevailing trends in clothing consumption in Norway.

Moreover, to broaden the research findings, official statistical data from the Statistics Norway-SSB website—a recognized authority in compiling national statistics—was extensively referenced to substantiate the findings and gain a broader perspective. This statistical data was important in quantifying the sheer volume of waste generated across Norway in cloth. A rigid examination of resources and documentation from various relevant organizations was conducted by reading the reports on each organization's website, like Fretex, UFF, and others. This multi-faceted and comprehensive approach was purposefully employed to ensure the accession of reliable, diverse, and complete data. This systematic data collection aimed to facilitate a detailed and thorough analysis of Norway's existing clothing consumption and waste

management systems.

2.3 Merial Flow Analysis (MFA)

Material flow analysis (MFA) is defined as a “systematic assessment of the state and change of materials flow and stock in space and time” (Paul H. Brunner, 2004). It helps to understand the connection between resources, flow, and the path of material. Based on Mariarosaria (Mariarosaria Lombardi, 2023), there are three types of MFA, including the one employed in this research:

1- **Qualitative Characteristics:** The study delves into the qualitative characteristics of a distinct metabolic system, focusing on selecting the most pertinent processes, primary material flows, and representative stock levels.
2- **Quantitative Characteristics:** This part of the research investigates the quantitative characteristics of a system's flows, processes, and stocks. It allows for the meticulous tracking of inputs, outputs, waste, and emissions from the initiation to the conclusion of the process.
3- **Ametabolic System Over Time:** This section emphasizes the temporal analysis of a metabolic system, offering the opportunity to examine past trends and potentially forecast prospects based on historical and current patterns related to resource consumption and waste generation.

MFA is a systematic method to precisely trace the movement of materials through various stages of a process or system. In the context of clothing collection, this approach provides a structured means to comprehensively understand the intricate pathways through which clothes are collected, processed, and managed, while also pinpointing the inherent challenges.
By applying Material Flow Analysis to the collection of clothes, we scrutinize every phase involved in the lifecycle of clothing—from their initial collection points to subsequent processing, distribution, and eventual disposition. This analytical method enables a granular examination of the steps undertaken by organizations and stakeholders in managing clothing waste. It helps quantify the volume of clothes collected, identify the routes they follow within the collection system, and elucidate the potential bottlenecks or obstacles encountered at each stage.

MFA is invaluable in illuminating the entire trajectory of clothing, including how clothes move through different channels, whether diverted for recycling, reused directly, or disposed of as waste. This meticulous analysis enables the discernment of inefficiencies, gaps, or challenges in the clothing collection process. These insights are fundamental in devising strategies to enhance the efficiency, sustainability, and overall effectiveness of clothing collection systems. In this study, a combination of qualitative and quantitative analyses was employed. . Qualitative methods were utilized to understand the entire clothing acquisition process, from the initial purchase to the reintegration of garments into the production cycle.

Using the formula below, quantitative methods were applied to assess the extent of clothing reuse, recycling, and waste generation and determine the potential for improvement in these areas.

(extractions + imports) = (consumption + exports + accumulation + wastes). (forms, 2012)

3 Theoretical Background

Comprehensive and informed investigations rely on a solid understanding of foundational research concepts. This section aims to delve into key concepts essential to the research's scope. Initially, we will explore the principles and components of the circular economy, elucidating its fundamental aspects and directions. Subsequently, attention will be directed toward the Supply chain and logistics sectors, examining their intricate relationship with the principles and implementation of the circular economy.

By focusing on the principles of the circular economy's principles, we aim to grasp its core tenets, including resource sustainability, waste reduction, and closed-loop systems. Understanding these principles is a foundation for understanding how economies can transition towards sustainable practices and mitigate environmental impact. The subsequent discussion about Supply chain and logistics within the circular economy context intends to uncover their challenges and opportunities. It explores how adopting circular economy practices influences supply chains, from production to distribution and logistics networks.

In the upcoming section, we will provide a succinct examination of the materials used in clothing. This will offer a comprehensive overview of the challenges and solutions associated with adopting circular economy principles in the context of fashion and textiles. Through this exploration, it is anticipated that valuable insights and potential strategies for advancing circular practices within these sectors will be identified and discussed.

3.1 Circular Economy

The concept of a circular economy (CE) has evolved and been defined in various ways. According to the United Nations, a circular economy is a production and consumption model focused on sharing, reusing, repairing, refurbishing, and recycling existing materials and products for as long as possible; in other words, the CE is extending the life cycle of products. (Circular economy: definition, importance and benefits, 2023) Blomsma (2020) asserts that any activity involving the recycling and reusing of materials can be considered part of a circular economy.

At its core, the circular economy is centered on maximizing material utilization or reutilization. As Oksana Seroka-Stolka noted in her work on green logistics and the circular economy (Oksana Seroka-Stolka, 2019), the essence of the circular economy lies in the optimal

utilization and utilization of materials. Within the circular economy context, Krichherr (2017) discusses two crucial aspects: the 'R frameworks' and the 'systems perspective.' The 'R frameworks' are the foundation of CE principles. Krichherr (2017) offers a comprehensive guide on how to implement CE practices. These frameworks come with various names, including 9R (Refuse, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, and Recover energy), 6R (Reduce, Reuse, Recycle, Remanufacture, Repair, and Refurbish), 4R (Reduce, Reuse, Recycle, and Recover), and 3R (Reduce, Reuse, and Recycle). Among these, 3R and 4R are the most widely recognized. However, these 'R' principles are often interlinked and not employed in isolation. For example, when we reuse items, we may simultaneously also undertake repair or refurbishment. (Julian Kirchherr, 2017).

Beyond the 'R framework,' the systems perspective emphasizes the necessity for substantial changes rather than minor improvements. This perspective asserts that to embrace CE fully, we must enact systemic changes at the macro, meso, and micro levels of the CE system. (Julian Kirchherr, 2017)

Therefore, we can conclude that the essence of the CE revolves around enhancing the value of used products through various methods. It is important to note that not all of these methods hold the same value. According to Achterberg (2016), the hierarchy of value places reuse above other methods, with remanufacturing ranking higher than recycling; this hierarchical order can be observed in Figure 3. (Elisa Achterberg, 2016)

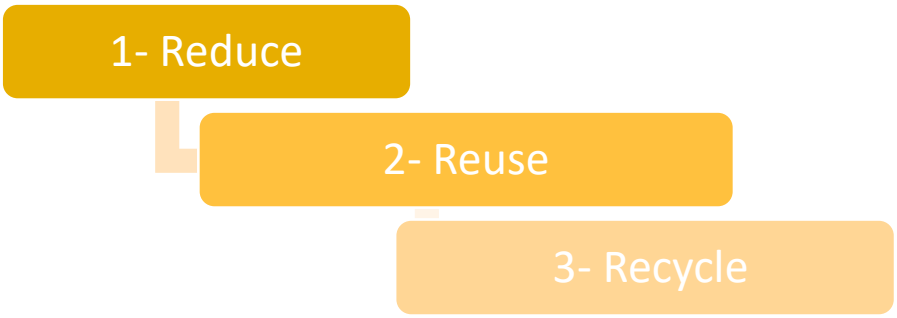

Figure 3: The Different methods of returning the material to the production cycle (Elisa Achterberg, 2016)

As explained by Ellen MacArthur, The circular economy concept is vividly represented in the 'butterfly diagram,' as depicted in Figure 4. This diagram serves as a powerful visual tool for comprehending the fundamental principles of the circular economy by structuring it into two core cycles: the biological cycle and the technical cycle. The biological cycle primarily centers on the return of materials to the natural environment, closely aligned with the inherent properties of the materials involved. (Ellen MacArthur Foundation, 2015)

On the flip side of the Macfee butterfly, we encounter the technical cycle, offering a route for products to re-enter the industrial production process. The stages outlined in this wing illustrate the diverse mechanisms for product reintegration into the production cycle. Chemicals and materials, for instance, often find new utility through this technical cycle. Consider clothing a prime example: garments can be refurbished, repaired, or disassembled to generate new items, effectively breathing fresh life into the constituent materials. (Ellen MacArthur Foundation, 2015)

The Macfee butterfly diagram encapsulates the core principles of the circular economy, emphasizing waste reduction and resource preservation. Serving as a visual guide, it illustrates how products can either return to the natural environment or rejoin the industrial cycle, contingent upon their composition and characteristics. Therefore, it underscores the importance of assessing the lifecycle of products and materials to minimize environmental impact and foster sustainability. (Ellen MacArthur Foundation, 2015)

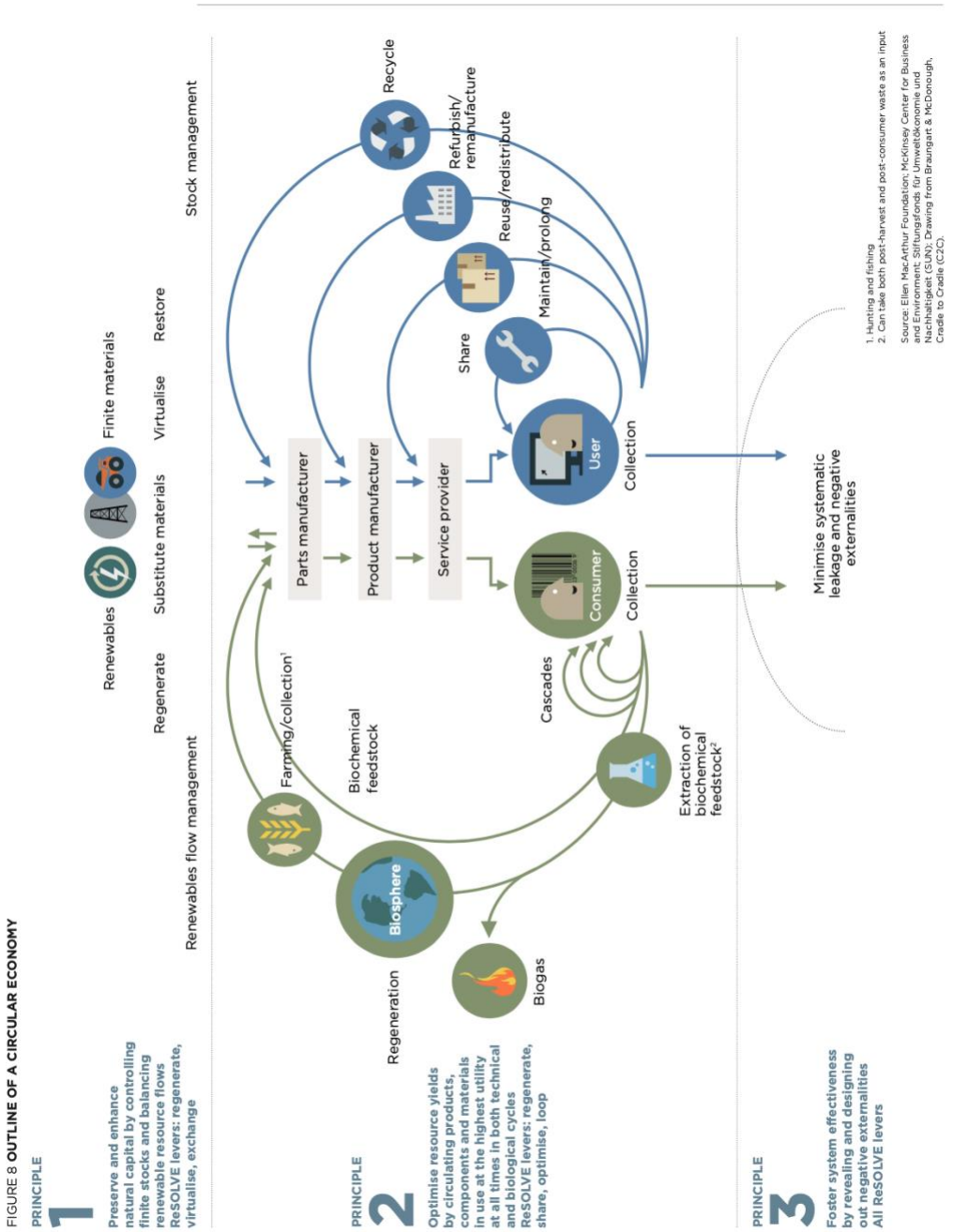

Figure 4:Butterfly diagram (outline of a circular economy) (Ellen MacArthur Foundation, 2015)

3.1.1 Advantages of Circular Economy

The increasing population and utilization of natural resources have led to a corresponding increase in waste production. This upward trend contributes significantly to the emission of greenhouse gases and environmental degradation. In response, the circular economy appears to be a suitable solution to this problem by recommending the reuse and waste minimization principles. (Younis Ahmad Hajama, 2023)

Furthermore, the global difference in the distribution of resources has prompted a strategic shift aimed at reducing dependence on raw materials through the optimal utilization of existing resources. This approach minimizes the continuous extraction of new resources, promoting a more sustainable and efficient use of available materials. (Circular economy: definition, importance and benefits, 2023)

Implementing the circular economy in industries shows their commitment to social responsibility and promotes a positive image that attracts and retains loyal customers. Companies adopting eco-friendly methods manage better customer relationships in today's landscape, where environmental concerns play a key role. By adopting circular economic principles, industries showcase their commitment to sustainable methods, reduced waste, and resource efficiency. As a result, more loyal customers will be attracted to them. (Kadio, 2023)

3.1.1 Challenges in the Circular Economy

Transitioning toward a circular economy represents a significant shift in economic practices, accompanied by various challenges. These obstacles, as delineated by Geng (2008), encapsulate three pivotal aspects: policy, technology, and public participation.

Policy: The regulatory framework within a nation plays a pivotal role in incentivizing companies to alter their strategies. However, not all countries possess conducive policies that facilitate the adoption of a circular economy. For instance, the taxation system in China levies the same value-added tax (VAT) on all companies, resulting in entities utilizing recycled materials facing higher taxes than those using raw materials, thus favoring raw material usage. (SY, 2005)

In contrast, Europe, particularly the EU, has enacted significant legislation to curtail waste production, providing industries with a more favorable environment to transition. In recent

years, the European Commission has introduced robust measures to bolster a circular economy, emphasizing sustainable in product design. (Circular economy: definition, importance and benefits, 2023)

Technology: The current technological sophistication for recycling certain materials, such as textiles, must be improved. There is a growing need for advancements in recycling technology specific to textiles, as the current state makes incineration a more viable option than recycling. (Aya Abdelmeguid, 2022)

Public Participation and Economic Factors: A prevailing challenge lies in shifting consumerist trends, particularly in industries like fast fashion. Numerous industries prioritize financial gains by appealing to consumer preferences. This trend is more pronounced in certain regions, such as the United States, where consumerism often trumps environmental considerations. Conversely, a more significant portion of the populace is concerned more about European environmental impact. As highlighted in the advantages section, this environmental consciousness presents an advantage for European countries in contrast to the scenario in the United States. Cultural differences among nations play a significant role in shaping these attitudes and behaviors towards sustainability and consumerism. (Ľubica Knošková, 2019)

In conclusion, the challenges in embracing a circular economy span policy, technological limitations, and varying degrees of public engagement influenced by cultural and economic factors across different regions. Addressing these challenges requires a concerted effort from policymakers, technological innovators, industries, and the general populace to collectively steer toward a more sustainable and circular economic model.

3.2 Supply Chain and Logistics

Logistics and supply chain management are vast topics that, due to time constraints, will not be exhaustively detailed in this discussion. In Sections 3.2.1 and 3.2.2, we will provide a basic overview of the key concepts relevant to this thesis. This will include looking at the leading logistics and supply chain management elements and how they relate to the CE. We will also explore how the CE affects these elements and discuss their interconnectedness.

3.2.1 Supply Chain: Types and Details

Based on Beames, a supply chain encompasses all the parties, directly or indirectly, involved in the movement and transformation of goods and services from the point of origin to the end customer, as shown in Figure 5. These activities go throughout product supply chains, including extraction of the raw material, manufacturing of the final product, and its delivery to the customer. (Alistair Beames, 2021) ,

Figure 5: Linear Supply chain (Circular Supply chain, 2020)

The Traditional supply chain operates linearly, but with the growing emphasis on reusing materials and implementing circular economy principles, a newer concept known as the closed-loop supply chain has emerged. In this part, we will provide an in-depth explanation of both concepts.

3.2.1.1 Different Types of Supply Chain

There are two types of supply chain: linear supply chain and closed loop supply chain. In a linear supply chain, within the product life cycle, goods often end up as waste with no return to the production cycle, as shown inFigure 5. This occurs because, in this type of supply chain, the primary focus is on an organization's sales and profits, with less emphasis on sustainability. (E. Manavalan, 2021)

Today, a new concept has been presented for the supply chain which is a closed-loop supply chain. The definition of a Closed-Loop Supply Chain (CLSC) is based on V. Daniel (2008) *the design, control, and operation of a system to maximize value creation over the entire life*

cycle of a product with the dynamic recovery of value from different types and volumes of returns overtime." In general, as you can see in Figure 6 the CLSC encompasses the entire life cycle of production, including both the forward supply chain (comprising processes from raw materials to customers) and the reverse supply chain (comprising processes such as recycling, reusing, repairing, and remanufacturing, depending on a company's strategic approach). (M. Simonetto, 2022)

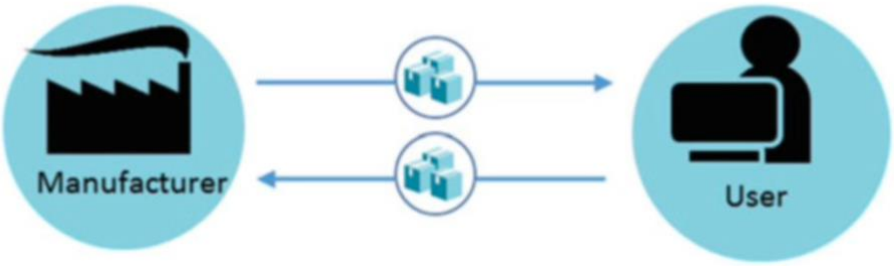

Figure 6: Forward and reverse supply chain (M. Simonetto, 2022)

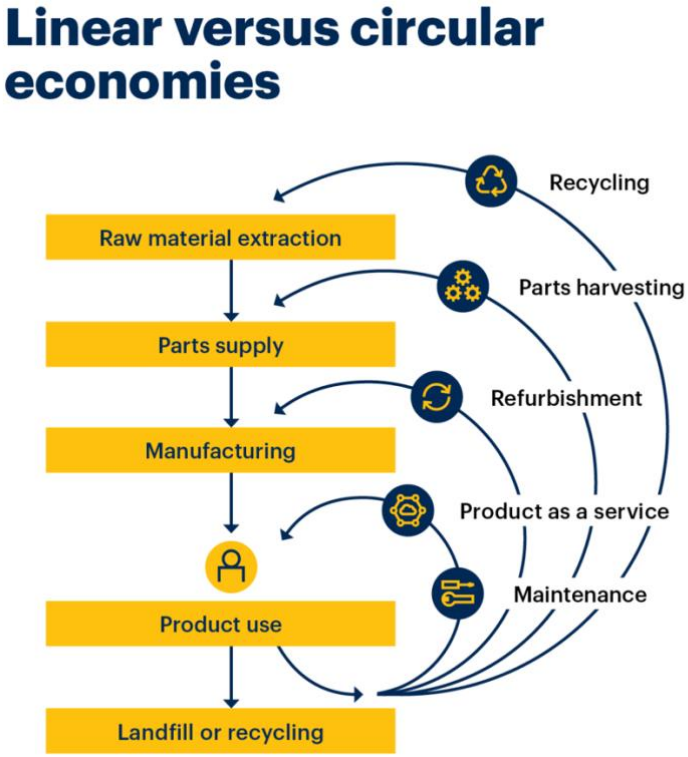

Figure 7:Linear Versus Circular economies

3.2.1.2 Effect of the circular economy on the supply chain

In the circular economy context, returning used products to the production cycle leads to having a CLSC in production. CLSCs can be examined from the perspective of the type of returns. As depicted in Figure 8, the Ellen Macfee butterfly diagram illustrates that the strategies employed (such as recycling, Reuse, remanufacturing, and others) result in distinct changes in the elements of the reverse supply chain when products are reintegrated into the production process. This variation occurs because they return to different segments of the forward supply chain, as shown in Figure 8. In essence, the specific approach chosen for product reintegration into the production cycle significantly influences how the elements of the reverse supply chain function. (V. Daniel R. Guide J. L., 2008)

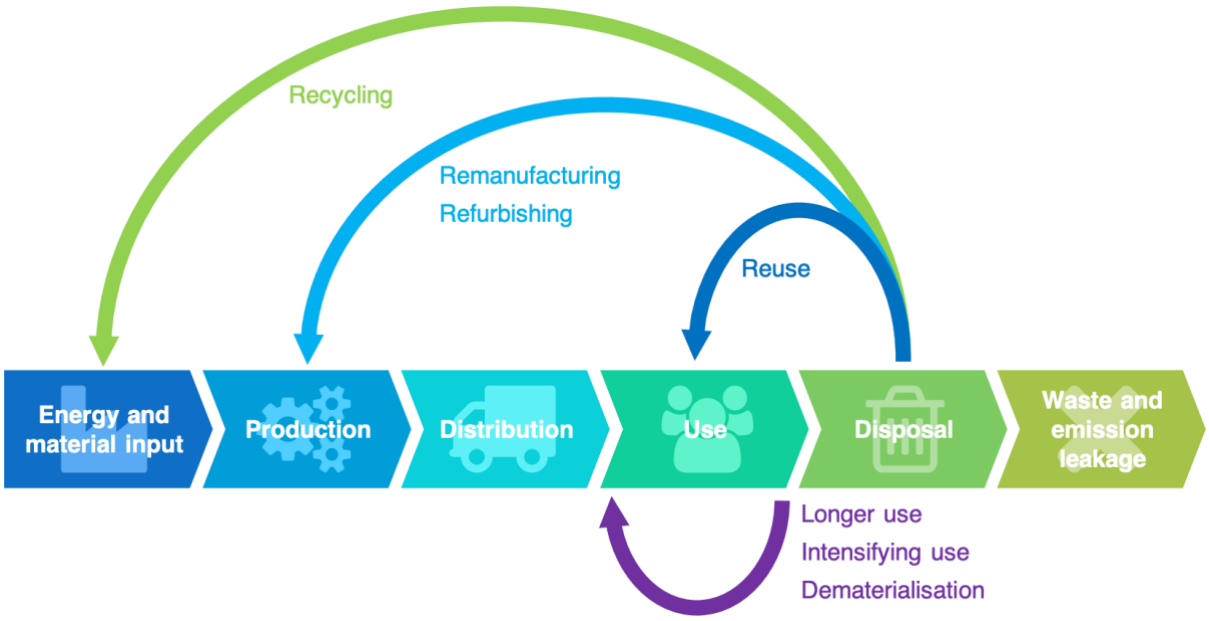

Figure 8: Methods Utilized in the Circular Economy and Their Reintegration into the Supply Chain (Alexandru-Polifron, 2023)

3.2.2 Logistics: Details and Elements

When it comes to the supply chain, the inseparable part is logistics, encompassing all business activities essential to fulfill consumer demand. These activities are from raw material extraction to the production of finished goods. (Alistair Beames, 2021)

3.2.2.1 Elements

Based on Alistair (2021), when discussing logistics, it encompasses more than just transportation and can be categorized into three essential parts: (Alistair Beames, 2021),

1. **Strategy:** This involves decisions regarding the scale of production, the location of facilities (such as production plans, warehouses, and distributors), and the overall planning process.
2. **Allocation:** Referring to the distribution of resources or products in response to demand, ensuring efficient delivery to the appropriate places or individuals.
3. **Material Flow Planning:** This involves the detailed planning of material flow within and outside the premises of each stakeholder involved in the logistics chain.

3.2.2.2 Effect of the Circular Economy on Logistics

It is crucial to recognize that supply chain and logistics are deeply intertwined in understanding the dynamics of the circular economy. This necessitates reevaluating decisions made within the context of a linear economy when products are primarily used and discarded. (Nancy M. P. Bocken, 2016)

In a linear model, decision-making primarily revolves around product creation, distribution, and sales. However, the transition to a circular economy introduces additional critical considerations. Geographical location has increased significance, particularly concerning the forward and reverse supply chains where products are collected, refurbished, or recycled as mentioned in part 3.2.1.2. (M. Simonetto, 2022)

Additionally, the type of service provided and its design play significant roles in ensuring the effectiveness of the reverse supply chain. (V. Daniel R. Guide J. L., 2008) Therefore, the decisions previously tailored to the linear model must undergo revision and expansion to address the complexities inherent in the circular economy, which integrates forward and reverse supply chains. (Nancy M. P. Bocken, 2016)

Given the intricate nature of these decisions, they can be categorized into three distinct parts: (Alistair Beames, 2021),

1. **Centralization versus Decentralization:** The first challenge involves determining the optimal balance between centralization and decentralization of production and logistics operations. Decisions regarding whether to concentrate these functions in one location

or distribute them across various facilities have significant implications for circular supply chains. For example, the choice of location for returning the product and the site for services like repair or recycling based on strategy.

2. **Product-Oriented versus Service-Oriented Sales:** In a circular economy, shifting from a product-oriented to a service-oriented sales approach becomes pivotal. Companies must carefully consider how they provide services that extend the lifespan of products, enabling reusability, refurbishment, or remanufacturing.
3. **Coordination versus Collaboration:** The third challenge is establishing effective coordination or fostering collaboration within the organization. Circular supply chains often require close collaboration among stakeholders, ranging from suppliers to customers, to ensure the smooth flow of products and materials.

In conclusion, transitioning to a circular economy necessitates a paradigm shift in logistics and supply chain decision-making. Understanding and addressing these challenges is crucial for organizations looking to thrive in a circular economy landscape.

3.3 Clothing system

We emphasized in the introduction the importance of the apparel manufacturing sector in terms of waste output and energy usage. Thus, this section explores how the garment sector and material usage in textiles might benefit from the use of circular economy ideas. We examine the difficulties of using circularity in this industry. Furthermore, we start by talking about the different kinds of clothing materials since we understand that the material composition of clothes plays a crucial role in this context.

3.3.1 An Introduce to Clothes Martials

The clothes we commonly wear today are crafted from a diverse range of materials, which can be broadly classified into five primary categories: (Koszewska, Circular Economy — Challenges for the Textile and Clothing Industry, 2018)

Oil-Based Synthetic Fabrics: These materials are derived from chemical compounds from petroleum, with polyester being a prominent example. (Team, 2023)

Cellulosic and Protein-Based Fabrics (Including Cotton): This category encompasses materials made from plant-based cellulose fibers like Cotton and protein-based fibers. (Preferred Fiber & Materials Market Report , 2020)

Wood-Based Cellulose Fabrics: These fabrics are produced from cellulose sourced from wood pulp. (Preferred Fiber & Materials Market Report , 2020)

Natural Fibers: Natural fibers are obtained from various sources such as plants (e.g., linen, hemp), animals (e.g., silk), and other organic materials. (Preferred Fiber & Materials Market Report , 2020)

Wool: Wool is a natural fiber derived primarily from the fleece of sheep, but it can also be sourced from other animals like goats (e.g., cashmere or mohair) or rabbits (angora). (Preferred Fiber & Materials Market Report , 2020)

Figure 9 illustrates the distribution of materials used in clothing production, with the majority of materials falling under the category of oil-based synthetics, accounting for 62.8% of usage. In contrast, wool constitutes the smallest percentage, at just 1.1%. (Koszewska, Circular Economy — Challenges for the Textile and Clothing Industry, 2018)

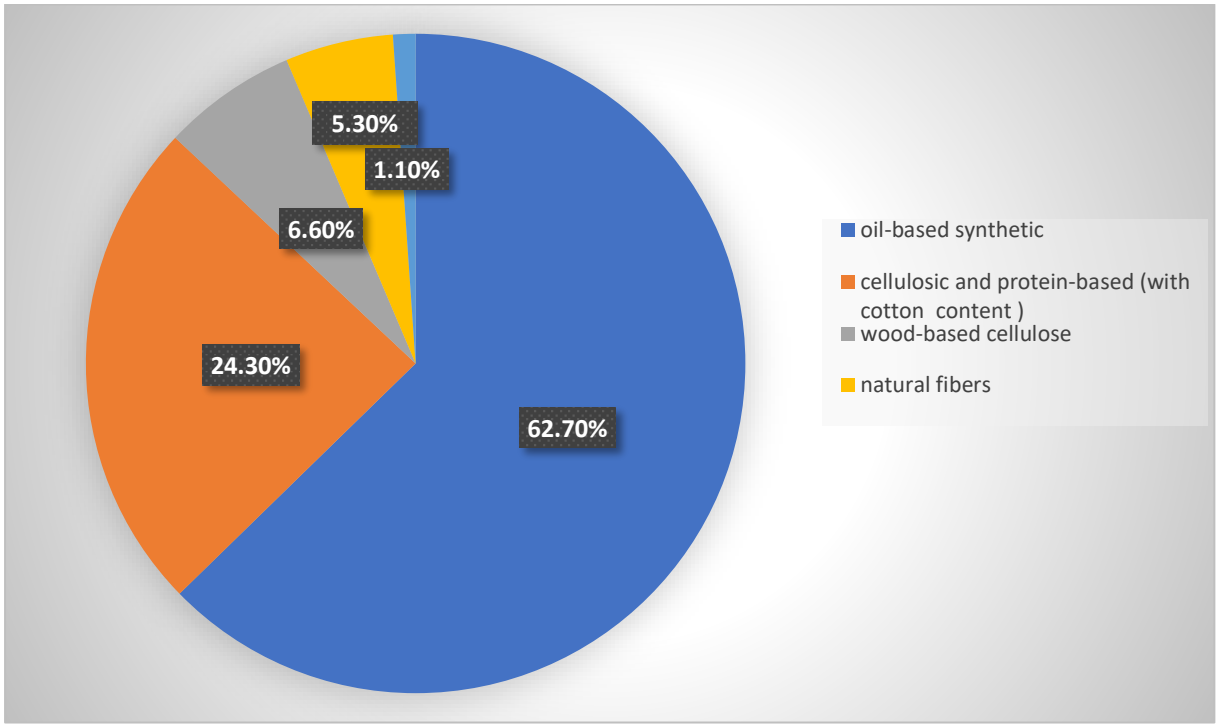

Figure 9: Market share of main fibers (Koszewska, Circular Economy — Challenges for the Textile and Clothing Industry, 2018)

This categorization of clothing materials provides insight into the diversity of resources employed in the fashion industry, each with its unique characteristics and environmental implications.

For more detailed separation in clothing material, we can categorize fibers in two main categories: Natural and manufactured. Further segmentation within each category is illustrated in Figure 10, providing a comprehensive overview of all material types. (Prabod Munasinghea, 2021)

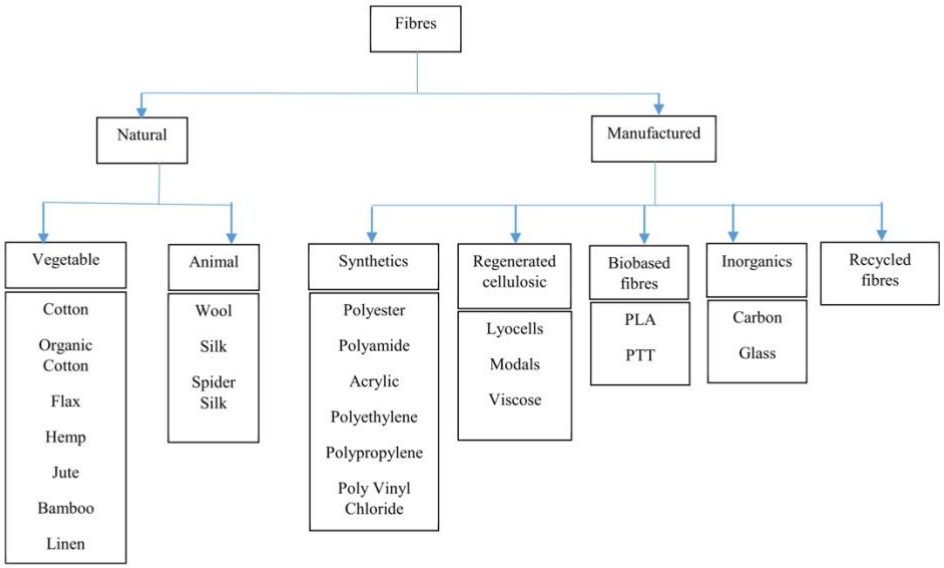

Figure 10:Types of fiber in cloth (Prabod Munasinghea, 2021)

3.3.2 Circular Economy in Clothing (fashion): Solutions and Challenges

The concept of the circular economy for clothing, often called the circular economy in the fashion industry, aligns with the definitions of the circular economy discussed in the preceding section. However, (Weerasinghe, 2021) has offered an extensive explanation of the circular economy in fashion, which is:

"A fashion system that moves towards a regenerative model with improved use of sustainable and renewable resources, reduction of non-renewable inputs, pollution, and waste generation, while facilitating long product life and material circulation via sustainable fashion design strategies and effective reverse logistics processes " (Weerasinghe, 2021)

3.3.2.1 Solutions for the Circular Fashion Industry

In this context, McAfee has outlined three visions for a circular production cycle for Dada clothing, as follows:

1. "*New business models that increase clothing use.*
2. *Safe and renewable inputs*
3. *Solutions so used clothes are turned into new.*" (Fashion and the circular economy – deep dive, 2023)

In a broader context, the efforts to establish a circular production cycle for clothing can be categorized into two main parts:

1. Actions about the production cycle aim to improve material quality and extend the product's lifecycle. These encompass design-oriented measures.
2. Actions associated with the end of the production cycle aimed at waste reduction, including recycling. This framework is illustrated in the diagram below.

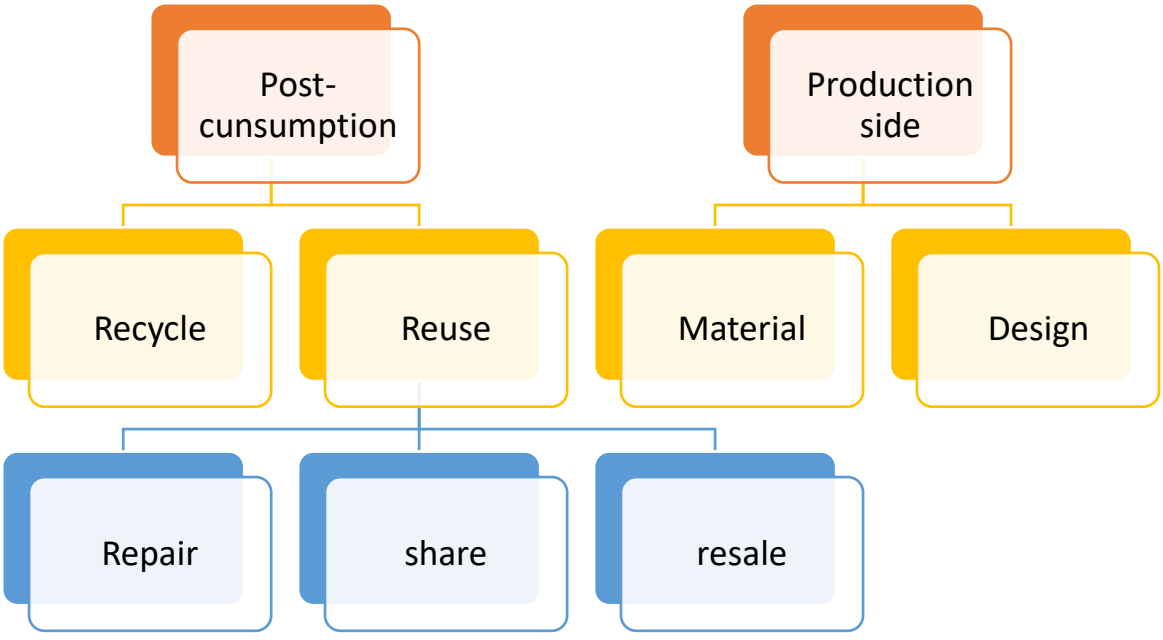

Figure 11:Overview of solutions to CE in Clothing system

1- Recycle: "*Converting waste materials into new materials and objects*" (Recycling, n.d.)

2- Reuse: Using the material again includes different methods.
    - **Repair:** Repair involves fixing clothing items that are damaged or worn. This can include sewing up tears, mending holes, or replacing buttons and zippers. The goal is to extend the lifespan of garments by keeping them in wearable condition.
    - **Resharing:** Resharing refers to sharing or lending clothing items among individuals. This can be done through clothing swaps, where people exchange garments they no longer need, or through platforms that allow users to borrow clothing for a specific period, like what happens to wedding dresses today. Resharing actively promotes the reuse of clothing and reduces the need for everyone to purchase new items individually.
    - **Resale:** Resale involves selling clothing that is no longer needed. Many people opt to sell their gently used clothes, either through physical stores or online platforms. Resale allows others to purchase pre-owned clothing, providing a more sustainable and cost-effective alternative to acquiring brand-new garments.

Implementing a combination of these methods within a single clothing system is possible. This comprehensive approach can maximize the system's sustainability and efficiency, offering various options for managing clothing throughout its lifecycle.

3.3.2.2 Challenges Regarding to Having Circular Clothing System

Based on papers when considering the implementation of a circular economy in the clothing industry, numerous challenges lie ahead, as discussed in various sources. Below, we outline some of these challenges:

1- **Sorting the cloth:** Distinguishing between clothes, especially in the case of unisex garments and those crafted from a blend of materials, is a significant challenge. As you see in section 3.3.1, there are a lot of type of material that clothes made from also, it should be noted that textiles and clothing comprise a complex mix of natural and synthetic fibers. The recycling process for such items demands the extraction of these materials. However, when clothing reaches the end of its lifecycle, alternative outcomes

may ensue, such as incineration, particularly when materials prove challenging to separate for recycling. This example underscores the biological cycle's intricate interplay between nature and industry. (Koszewska, 2018)

2- **Recycled materials do not have good quality;** according to (Morlet A, n.d.) only 12% of clothing gets recycled, and less than 1% returns to the clothing system, while the majority is repurposed into low-value products like cleaning clothes.
3- **Complexity and number of stakeholders**: Transitioning to a circular system in China faces challenges due to the involvement of numerous stakeholders within the supply chain. (Ki CW, 2020)
4- **Manually sorting:** In the first place, the manual sorting of clothing for resale, repair, recycling, or disposal can be time-consuming and costly. (Towards a Nordic textile strategy, 2014)

Effectively tackling these challenges represents a pivotal step in accelerating the transition towards a circular economy within the clothing industry. Overcoming these hurdles holds the potential to expedite the adoption of circular practices and drive substantial positive change across the various sectors associated with the clothing industry.

4 Personal Clothing System in Norway

This section comprises two distinct segments. The first, Section 4.1, provides a comprehensive overview of clothing consumption in Norway and the subsequent fate of these cloths in 2022 to have an overview of the amount of cloths. In Section 4.2, the various entities and organizations involved in managing the clothing life cycle within Norway are examined in greater detail. Exploring these sections will better understand Norway's clothing system and the key players in collecting clothes.

4.1 Statistics of the Norwegian Clothing System

According to the research conducted by Norus and Norion Consult in 2022, approximately 105.913 tones of new textiles were added to the Norwegian market, including clothing, footwear, and household textiles. This equates to an average of 19.3 kilograms of new textiles per person. This quantity is higher compared to a survey conducted in 2019, which was 99,129 tones and did not include footwear and leather goods. Notably, 105,429 tones of this total were imported from other countries, and 1,084 tones were produced in Norway, accounting for 99 % of all clothes imported as illustrated in Figure 12. Also, domestic production in the Norwegian market that exports to other countries amounted to 600 tones, representing 0.5% of the total. (Synnøve Rubach, 2023)

Furthermore, approximately 88% of these textiles were estimated to be consumed by private households, which is almost 93,203 tones. From this amount, cloth and footwear, includes 88,233 tones of total cloths, averaging around 16.9 kilograms per person. At the same time, professional and public clothing, including uniforms (etc.), used the remaining portion, as you see in Figure 13 and Table 4, which shows an overview of the textile type of cloth that is used in private households. In addition, of 105,429 tones that were imported to Norway, 84% of them are clothing and footwear, which is a big part of the import, with the remaining 16% comprising household textiles such as bed linens, towels, and tablecloths, as shown in Figure 14. (Synnøve Rubach, 2023)

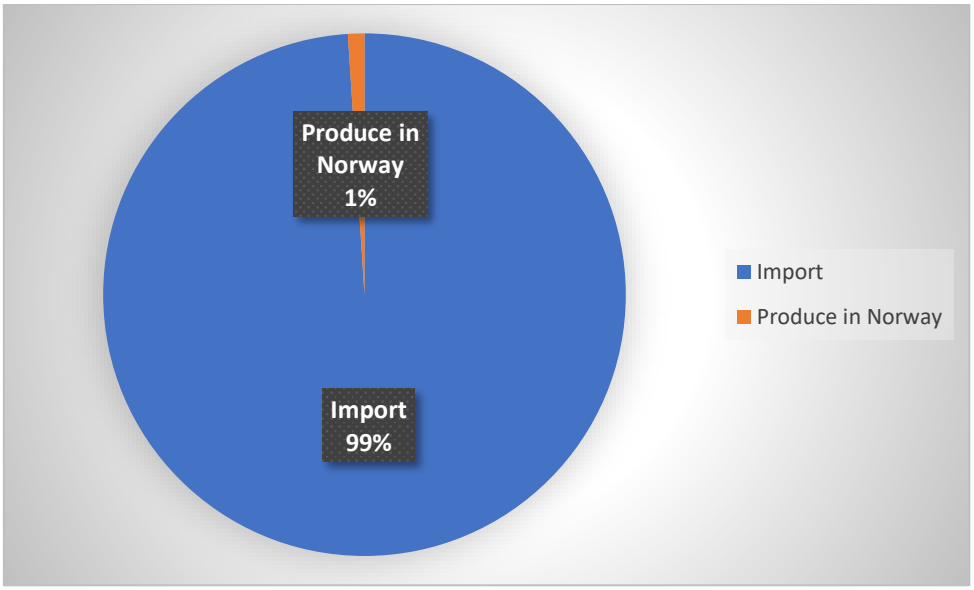

Figure 12:Overview of amount of clothes production in Norway and import

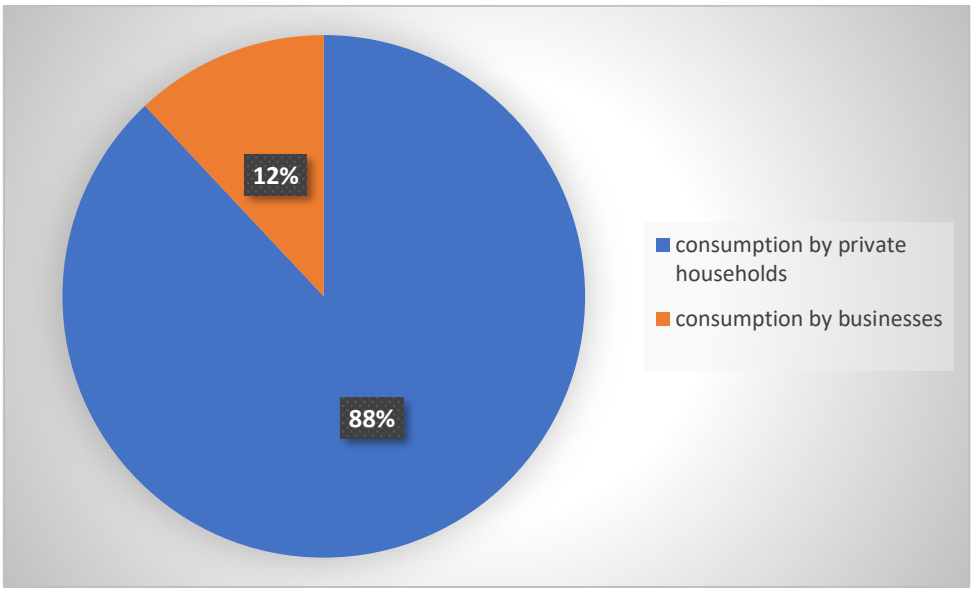

Figure 13: consumption of textile in private household and business sectors in Norway

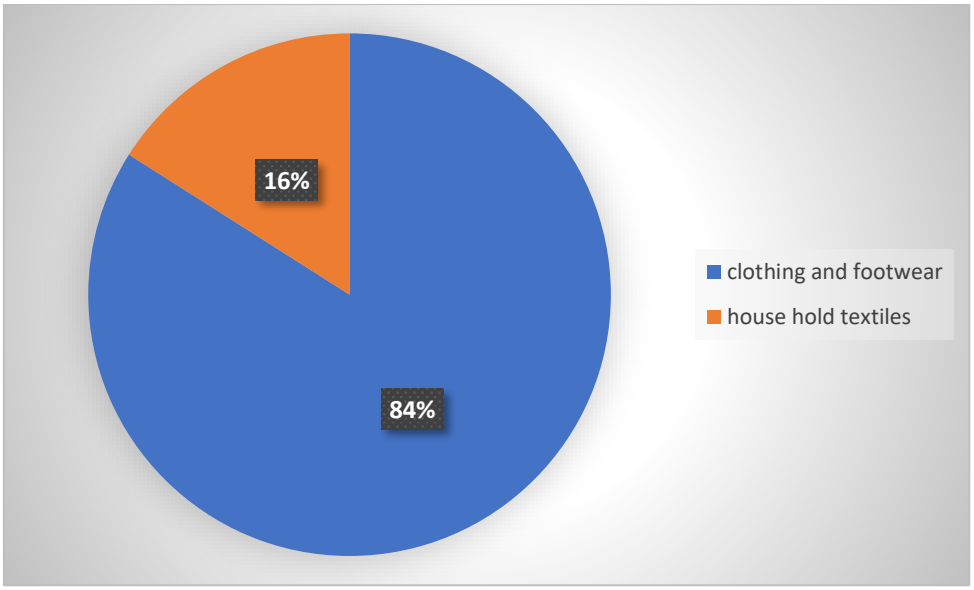

Figure 14: The share of various textile consumption

Table 4: Overview of material type of waste clothes from SSB in 2022(Translated from Appendix B)

Material	Ton	per cent
Cotton	25395	28,64183885
Synthetic fibers	22554	25,43760715
Only stated as textiles, etc.	20478	23,09618334
Plastics	10621	11,9789317
Leather	6576	7,416764414
wool and animal hairs	2891	3,26062438
fur	103	0,116168907
silk	46	0,05188126
linen	0	0
total	88664	100

In 2022, Norway imported 259 tonnes of used clothing and other used goods and 2,113 tonnes of textile waste, including rags and similar items. Also, in 2022, 80,565 tones of clothes were thrown away, 78,193 were produced in Norway, and 2,372 tones were imported. After collecting 50,955 were burned, 31,642 were exported to other countries, and just 909 tones were re-used in Norway, almost 1% of the total. Because there is no recycling facility in Norway, this amount is 0; Figure 15 illustrates the overview of wasting clothes. From this amount, 29,643 tones were collected by private and charitable organizations, and around 2500 were exported. The 33,600 tones ended in the rest of the fall that was collected with MSW.

Lastly, there is a discrepancy of 17322 tones between the textiles introduced to the market in 2022 and those disposed of through various channels. This gap could be attributed to household textiles, private sales or exchanges, or disposal via different routes for public and private entities. It is important to note that the figures for the total mass balance are still being determined due to the varied lifespans of textile products, ranging from a few days to several decades before disposal. (Synnøve Rubach, 2023)

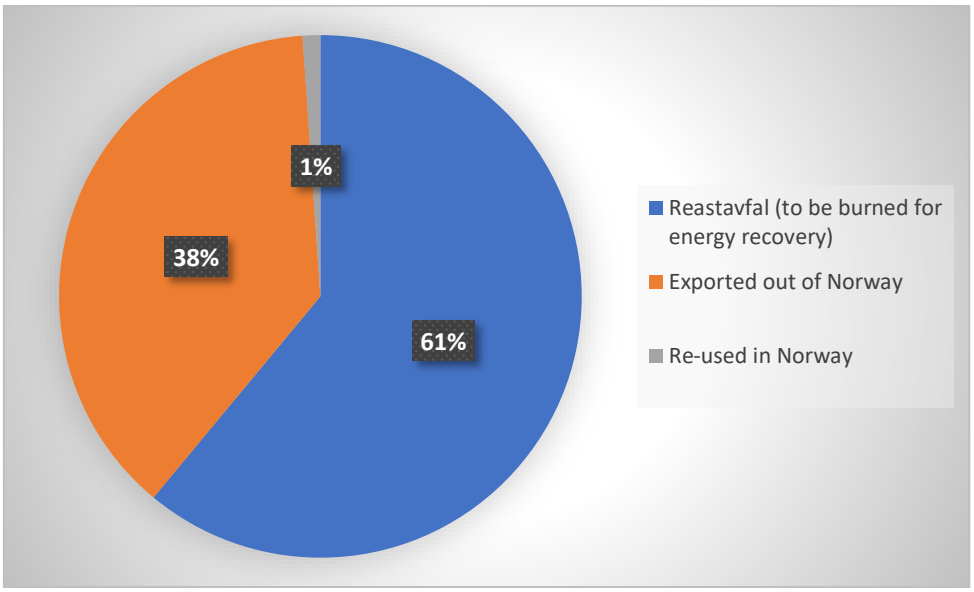

Figure 15: Overview of waste clothes in Norway

Here in Figure 16 shows the material flow of clothes in Norwegian clothes system.

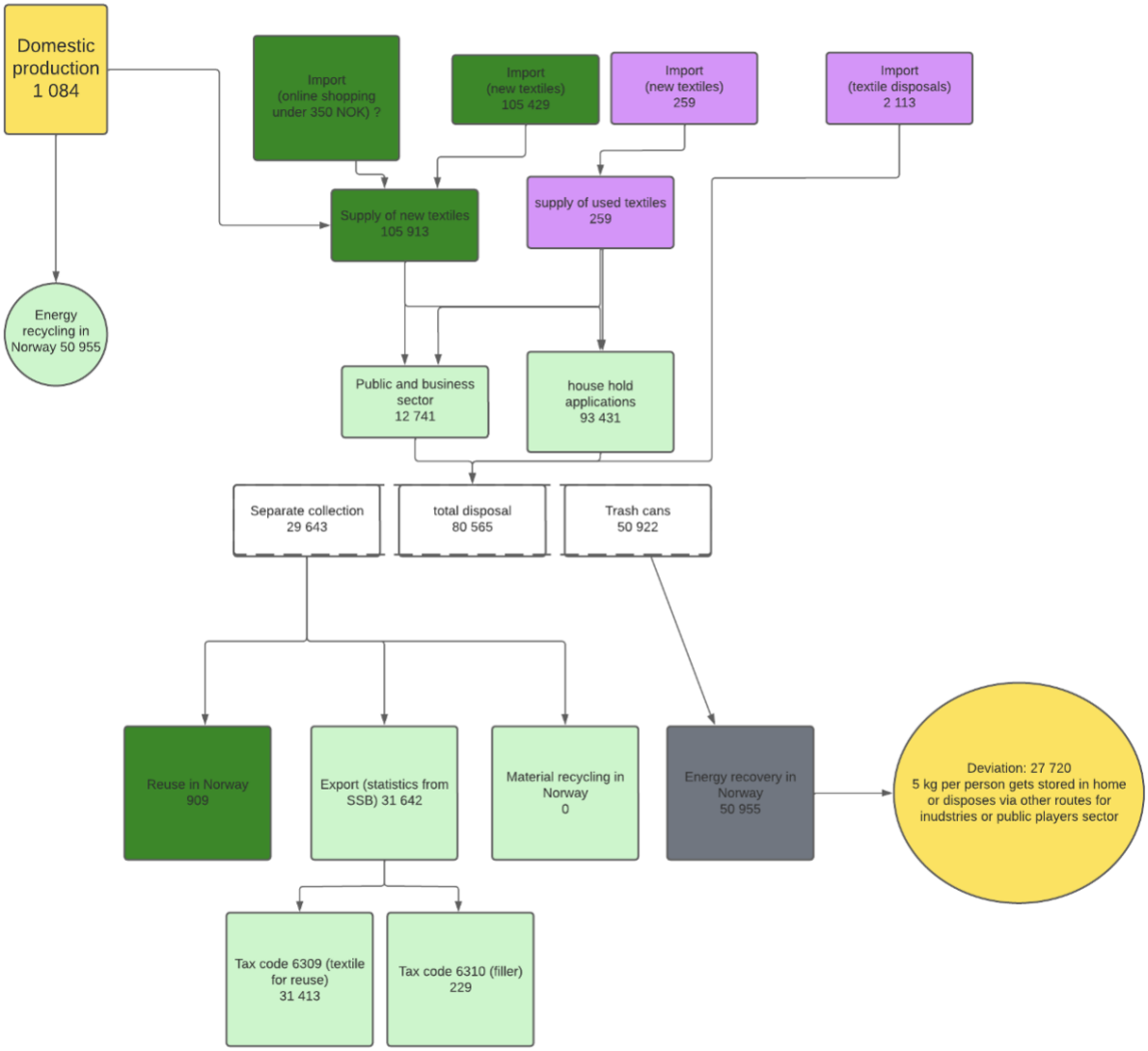

Figure 16: Overview of material flow of clothing in Norway(Translate from Appendix A)

4.2 Actors in Clothing Collection

Within the Norwegian garment industry, the supply chain may be broken down into two basic components. Pre-consumption is the initial phase, which includes the supply of raw materials, manufacturing, sales, and other associated activities. This phase comprises the whole process. The second one is centered on actions that take place after consumption, such as the gathering and distribution of apparel that has been previously worn. This thesis focuses on the second part, which details the material movement throughout each organization involved. This is because a substantial amount of Norway's apparel is imported, as was mentioned in section 4.1. In Figure 17, a comprehensive picture of the material flow in the clothing system is shown. This overview traces the sources of clothing items and their eventual destinations. It emphasizes the numerous phases that clothing goes through during its lifespan, beginning with its originating origins and ending with its ultimate destinations. These stages include the procedures of recycling, reusing, and disposing of garments.

A significant part of the process of collecting and dispersing used clothing in Norway is carried out by charitable groups. These organizations organize strategic collecting spots in close proximity to local retailers, making it easy for people to donate their clothing by providing them with handy venues to do so. The clothing that has been gathered is carried to warehouses on a regular basis for the purpose of sorting. Once there, they are sorted into categories that are either resold or donated according to the operating plan of each organization.
In different Norwegian cities, which are controlled by a variety of charity groups, the process of collecting and redistributing clothes adopts a variety of different approaches. It is vital to investigate the elements that influence the functioning of these organizations to accomplish the goals of comprehending the intricacies of Norway's clothing-collecting system and identifying the issues that it faces. This involves doing an analysis of the particular material flows that they manage. To evaluate the efficiency of the system, it is essential to have a solid understanding of these components.

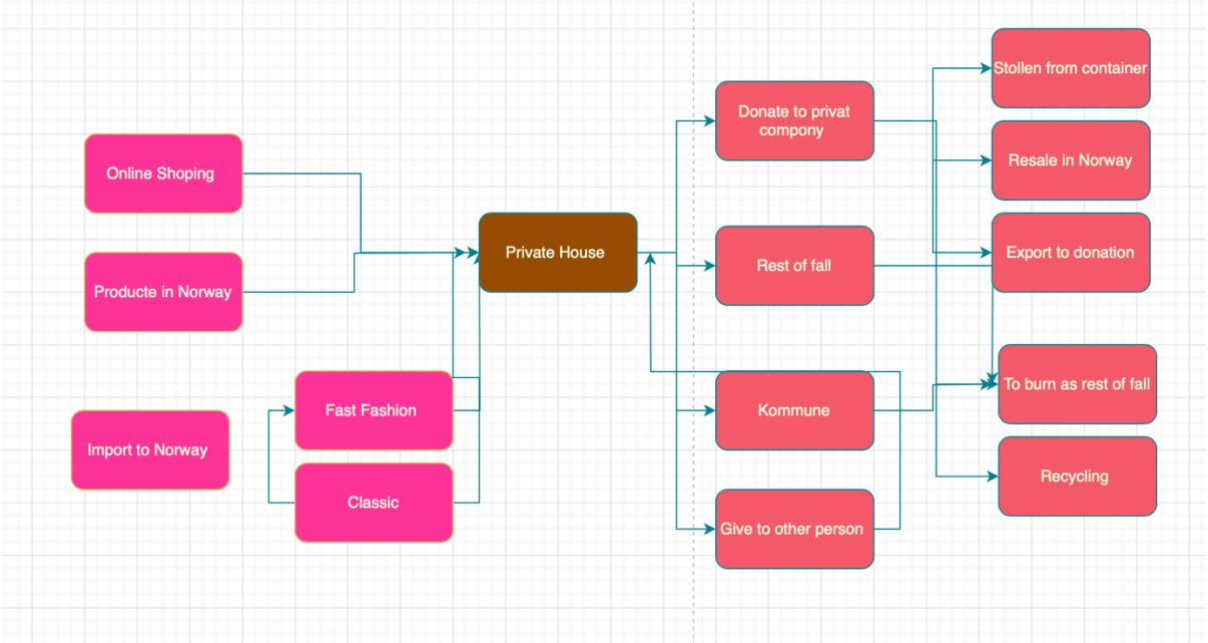

Figure 17: Overview of Material Flow in clothing system in Norway

4.2.1 Naturvernforbundet

Naturvernforbundet is a voluntary, non-profit, non-governmental organization founded in 1914 under the name Landsforeningen for Naturfredning in Norway. Later, it was called the Norwegian Nature Conservation Association. It is Norway's oldest, largest, and leading nature and environmental protection organization. (Olerud, 2023)

The organization's original purpose was to protect the country's nature with its wildlife, plant life, and uniqueness. Today, the Nature Conservation Association works with everything that falls under the modern concept of nature and environmental protection. The organization conducts extensive information activities for the general public, takes initiatives towards the authorities in nature and environmental protection matters, and speaks out in matters submitted to the association by the authorities. In addition to its broad national involvement, the Nature Conservation Association runs projects with partners in several countries in Europe, Asia, and Africa. (Olerud, 2023)

Naturvernforbundet and Trondheim Public Library collaborate to organize a clothes- swap -day twice a year. The clothes- swap -day will be organized at the main library in Trondheim.

People can bring up to seven clean, whole, fresh items of clothing - and get change notes that they can use to get other items of clothing that other people have brought, without considering the price of the cloth.
Also, there will be an opportunity to have simple repairs and changes made to clothing. They provide experienced sewists, but people must bring extra parts like zips and buttons. (Den store klesbyttedagen Trondheim, 2023) In 2023, 230 clothes change days were organized across the country. (Den store klesbyttedagen Trondheim, 2023)

4.2.2 Fretex

Fretex has containers around the city, mostly close to shopping centers, for collecting the clothes, where people can put their clothes in bags and put them in container, this helps to separate the cloth into first place and people send re-useable clothes in containers. The bag of garments people deposit in their local Fretex container goes through several steps before it ends up in a hangar in Fretex stores. As presented in Figure 18 first, it is sent to sorting facilities in Oslo and Sandnes, where clothes are sorted in three groups, sale domestically, export and incinerated for energy production. (Åberge, 2020)
Approximately ten percent of the delivered clothes ends up in stores in Norway from this collection of textiles. The store's order from the sorting facilities is based on customer demand. The selected items are checked for quality, categorized, priced, and transported to the stores. Employees engaged in the Salvation Army's social work come to the sorting facilities and collect what is needed. (Åberge, 2020)
The remaining clothing, which is 90 per cent, is sent to other countries, such as Poland, where a similar process to that in Norway is conducted. However the final classification and sorting the close is different based on what customers desire, according to the Style and Fashion in the country. The rest is exported to countries in Eastern Europe, Africa, and Asia through Fretex International. Fretex International does not directly export to Africa. The goods that end up in Africa have passed through a sorting facility in another country, which Fretex International visits every year and is certified. Hence, we know that only reusable items are further sold in Africa. (Åberge, 2020)
Ultimately, the damaged cloth and unusable cloth is sent for energy recovery. However, this is not the best utilization of resources, and it creates additional costs for Fretex. (Åberge, 2020)

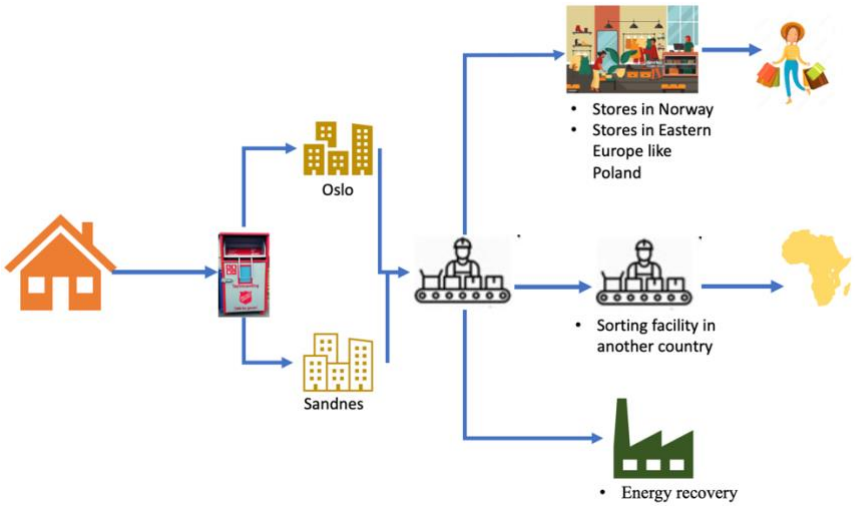

Figure 18: Material flow of Cloth handling in FRETEX (Åberge, 2020)

The surplus from Fretex goes toward the Salvation Army's social work. With these funds, the Salvation Army can implement measures where help is most needed for struggling families, individuals striving for a new life without substance abuse, lonely elders, inmates in Norwegian prisons, families not well integrated into Norwegian society, and vulnerable youths. (Åberge, 2020)

4.2.3 UFF

The collecting process is similar to Feretex; as illustrated in Figure 19 UFF has many of the same functions as Fretex. The main difference is that the clothes deposited in a UFF container in Norway go to sorting facilities in other parts of Europe before returning to stores in Norway, unlike Fretex, which has sorting facilities in this country. The clothes given to UFF are sorted, like Fretex, based on quality and season. UFF sends pictures and catalogs, visits sorting centers annually, and explains what sorters want in our stores in Norway. (Åberge, 2020)

Only 0.4 percent of the items deposited in UFF containers in Norway are resold domestically. Most of goods we find in UFF's reuse stores in Norway is clothing from countries other than Norway. (Åberge, 2020)

These items are sold directly in their stores. Clothing that remains unsold in Norwegian stores is then forwarded to affiliated European stores within their network. The quality of the clothing they sell in Norway is good, so their returned items still have high value; Examples of countries where the items not sold here are sent include Bulgaria, Germany, Sweden, Malawi, and Mozambique. (Åberge, 2020)

UFF collects clothing for reuse. Textile waste such as dirty clothes, underwear, or damaged clothes should be separated and disposed of as residual waste. It is important to emphasize that currently, there is no industrial-scale textile recycling. (Åberge, 2020)

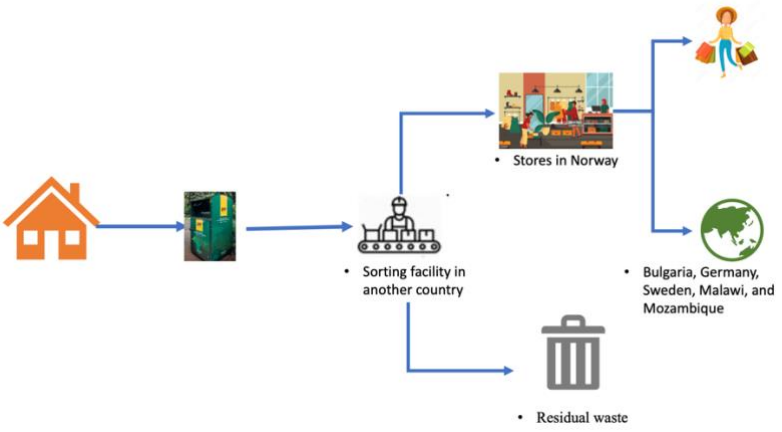

Figure 19: Material flow of Cloth handling in UFF

The revenue from clothing sales at UFF goes towards humanitarian work, such as health, education, environment, and agriculture, in African and Asian countries, such as Namibia, South Africa, China, and India. Most of the funds are used to ensure children's education and the training of elementary school teachers, as education for children in developing countries is a good investment for the future. (Åberge, 2020)

4.2.4 Kirkens Bymisjon

In Kirkens Bymisjon, they collect a lot of clothing. They have several reuse stores nationwide and multiple work initiatives dedicated to alterations and redesigns. Additionally, they have 1000 textile collection bins in Southern and Eastern Norway. (Ved å gi klær til gjenbruk støtter , 2023)

The main challenge in Norway is that a significant amount of clothing is disposed of in residual waste, thus not being reused or recycled. Through the textile collection bins, consumers who want to get rid of clothes can contribute to giving them a new life with someone else while also supporting the work of Kirkens Bymisjon.

They gather all textiles at their sorting facility in Drammen. There, they conduct primary sorting of the bags from the bins and forward them for finer sorting and subsequent distribution in Poland. About 95% of the clothes they receive are of good quality and are resold in used

shops/second-hand markets. Those that cannot be sold go for material recycling, turning them into rags or similar products.

Clothes that do not continue to be sold in second-hand stores in Eastern Europe are sold in African second-hand markets. Only fully sorted and packed clothes are sent there based on orders. The final destination of sorted clothes can be mentioned as follows:

80% is reused as clothing.

14% goes to material recycling – plaster filler, insulation, etc.

6% goes to energy recovery. (Ved å gi klær til gjenbruk støtter , 2023)

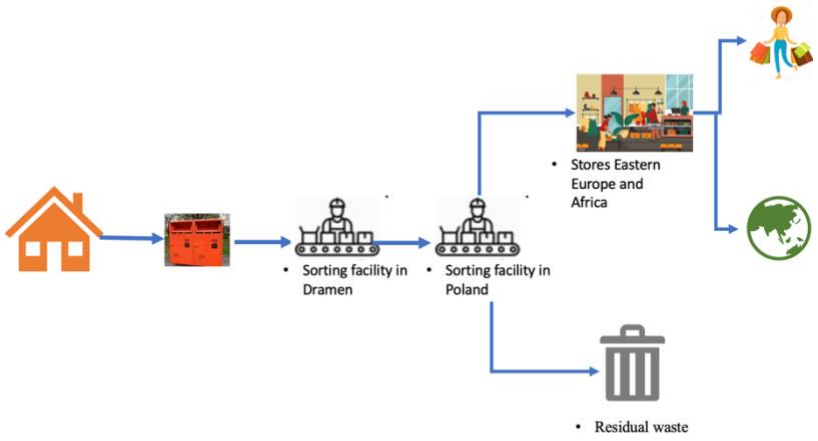

Figure 20: Material flow of Clothes handling in Krikken Bymisjon (Ved å gi klær til gjenbruk støtter , 2023)

4.2.5 Røde kors

The clothes delivered to the Red Cross can be reused or extend life by turning into new products, such as plaster fillers. For collecting the cloth trough Red-Cross, there are two ways: (Dette skjer med tøyet du leverer til Røde Kors, n.d.)

1- Give clothes to the Red Cross from home or via collection boxes.
2- Deliver clothes to the Red Cross via our collection boxes at selected locations in Eastern Norway or from home with our collection scheme.

The clothes are collected and transported to the Red Cross warehouse. The Norwegian Red Cross does not have facilities for sorting used textiles. At the same time, the demand for used clothes in this country is still small and less than the amount of clothes collected. Collected clothes from the collection boxes and the pick-up system are sold unsorted to buyers, mainly residents in Poland. The profit from this sale will go to the Red Cross' humanitarian work. A

small proportion of the collected children's clothes are sold in the Norwegian online store Levd, which the Red Cross owns. Most buyers have their own sorting facilities and second-hand shops. Some of the clothes go to other markets outside Poland, and about 82% of cloth is reused. Other cloths extend life by becoming new products, such as plaster fillers, furniture fillers, and insulation. About 16% of collected cloth is recycled. A small part of the textiles that can neither be reused nor recycled is burned for energy recovery, which is only 2%. (Dette skjer med tøyet du leverer til Røde Kors, n.d.)

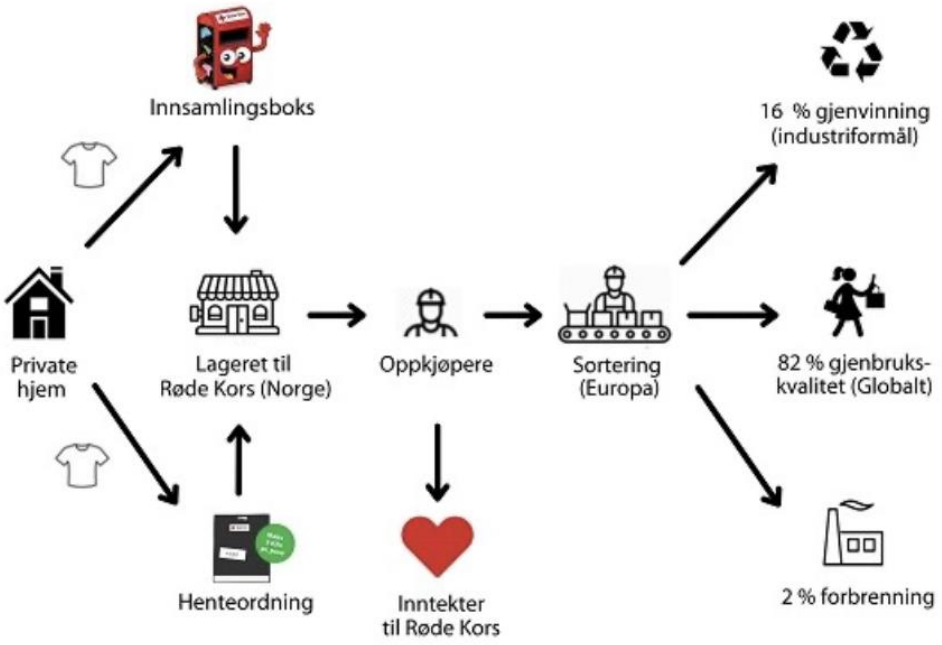

Figure 21: Material flow of Cloth handling in Rod-Kurs (Dette skjer med tøyet du leverer til Røde Kors, n.d.)

4.2.6 Municipality

The municipal program is responsible for managing household waste, a topic that will be extensively covered in the subsequent chapter. However, a critical issue arises within this system regarding clothing disposal. The collection points or canteens within the municipal program need a dedicated separation mechanism for gathering clothes. Consequently, most discarded clothing is indiscriminately discarded at collection points alongside wet garbage, leading to their eventual incineration.

Although there are designated locations where individuals can drop off their clothing, these designated spots are not widespread or easily accessible. This lack of widespread availability significantly hampers people's ability to dispose of their clothing responsibly. As a result, individuals often face difficulties finding suitable places to deposit their clothing for reuse, recycling, or appropriate disposal. This contributes to the prevalent practice of discarding clothing in waste streams, which are eventually incinerated along with other household waste.

5 Solutions for circular waste handling for clothes in other countries and another type of household waste in Norway

This section succinctly outlines the prevailing solutions adopted for various waste types in Norway, alongside a comparative examination with other nations employing analogous or differing approaches. The objective is to leverage insights garnered from Norway's past endeavors and those of other countries, recognizing the potential divergence in infrastructure due to geographical and political disparities. The discussion herein is bifurcated into two segments:

1. Norway's Strategies for Handling Other Household Waste
2. Comparative Analysis of Denmark and The Netherlands

Due to its comparable population and geographical aspects, Denmark is a pertinent comparison to Norway. Furthermore, two Dutch cities with different waste management methodologies distinct from Norway's have been investigated for comprehensive analysis and contrasting perspectives.

5.1 Norwegian Policy for Household Waste Management

Based on SNL website, waste is divided into household and industrial waste in Norway. (SNL, 2023)

Industrial waste: Industrial waste comes from public and private companies and institutions. Waste companies manage industrial waste, which often has a different composition than household waste.

Household waste: Household waste comes from private households. The municipalities are responsible for collecting household waste from residents. (SNL, 2023)

In the context of this research, due to the fact that this research main focused is on household waste we will further explain more about Norway's household waste collection system.

5.1.1 Household waste

Figure 22 illustrates that the total household waste generated in 2022 amounted to 2,124,000 tones. As previously highlighted, the municipalities are responsible for collecting and properly managing this significant amount of waste. (SSB, 2023)

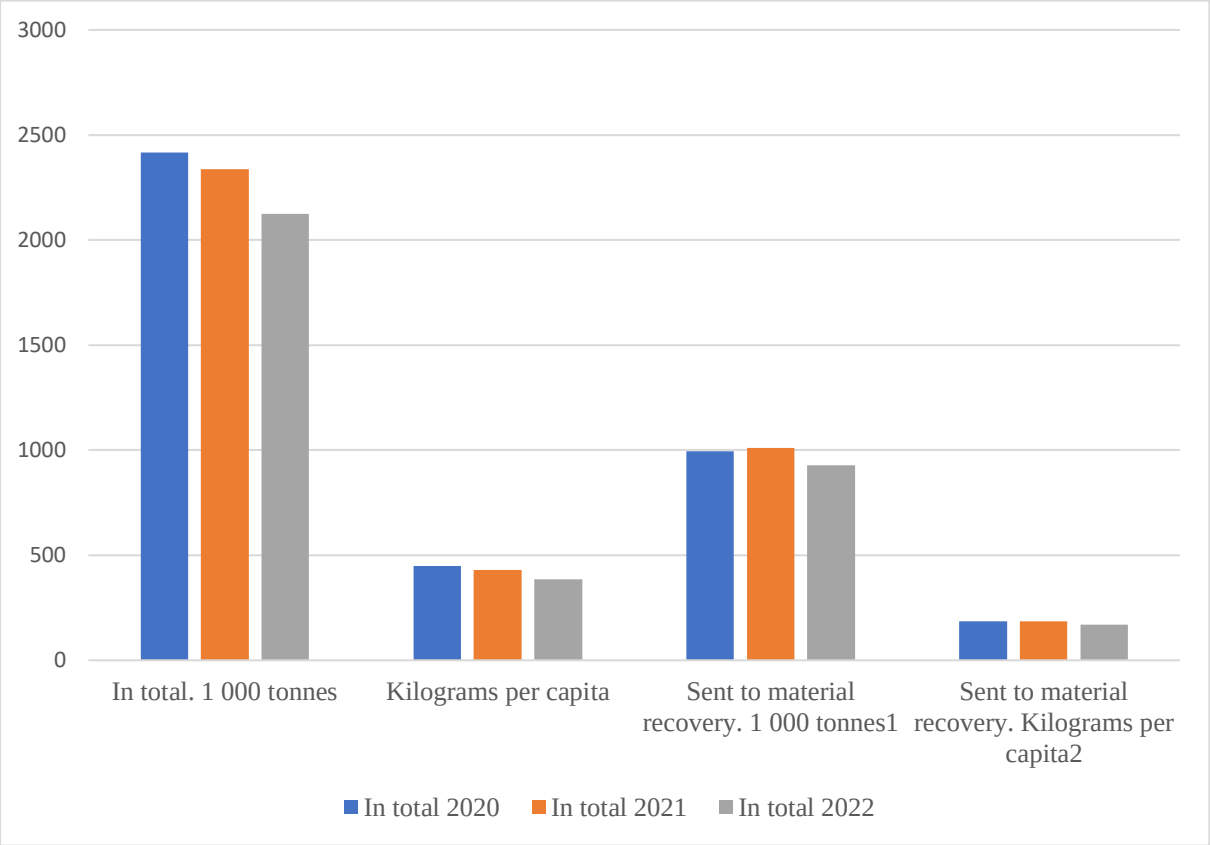

Figure 22: Overview of waste production in different years in Norway (SSB, 2023)

Household waste can be categorized into 16 groups according to Statistics Norway (SSB); in the

Table 5, as it illustrated the name, method, and place of collection in Trondheim MSW: (SSB, 2023)

Table 5: Overview of category of wastes in Norway (SSB, 2023)

Name in Norwegian	Name in English	Where
Restavfall	Residual waste	Permanently Container near home
Papp	Cardboard	Permanently Container near home
Matavfall	Food waste	Incouds inResidual Waste
Plast	Plastic	Container in near home
Glas	Glass	Permanently Container near shopping centers
Metall	Metal	Permanently Container near home
EE-avfall	EE waste	Take from Home (Twice per year)
Treavfall	Wood waste	Temporary Container near home centers ((Twice per year))
Hageavfall	Garden waste	Temporary Container near home centers ((Twice per year))
Tekstil	Textile	Incouds inResidual Waste
Farleg	Dangerous	Take from Home
Byggavfall	Construction waste	Special places in city (Like Heimdal in Trondheim)
Forureina/	Contaminates/	Special places in city (Like Heimdal in Trondheim)
Gips	Plaster	Special places in city (Like Heimdal in Trondheim)
Bildekk	Car tire	Special places in city (Like Heimdal in Trondheim)
Annen	Other	Inclouds other waste but separate them in sorting

Figure 23 illustrates the extent of waste collection across various categories between 2020 and 2022. It is evident from the data that the most significant volumes of waste correspond to paper and plastic materials. Conversely, the quantity of collected clothing is notably minimal, a topic to be elaborated upon in the subsequent section. Notably, despite a modest decline, there is a reduction in overall waste production, aligning with the principles of the circular economy. The forthcoming section will explore material flow, encompassing collection procedures and subsequent processes.

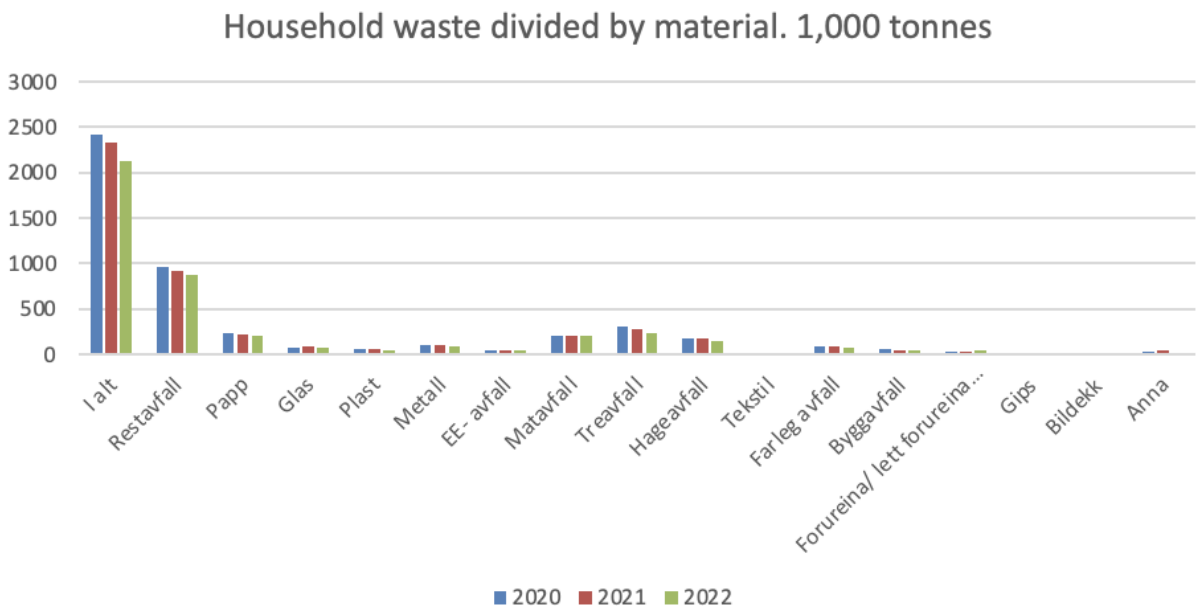

Figure 23:Houshold waste collection based on Material

5.1.2 The waste collection steps in Norway

The stages of garbage collection can be delineated into three primary parts, including:

Collecting the waste: As mentioned before municipalities in Norway typically is responsible for collection strategies. Waste in Norway commonly consists of paper and cardboard, plastic materials, residential waste, etc. that start a pre-separation from home (Westfall). Different groups of waste have different place to collect

Table 5 provides insights into the frequency and collection method for various waste types. It is essential to note that the municipality does not oversee the collection of clothing-related waste. Consequently, the amount of clothing collected is minimal, with most items discarded and wet waste. (SNL, 2023)

Post-sorting: Following the waste collection process, a post-sorting step becomes necessary as the collected waste is not initially segregated by material. Post-sorting involves the sorting of mixed waste after its collection. In Norway, two significant post-sorting facilities handle household waste: the IVAR post-sorting facility at Forus and the ROAF (Romerike Avfallsforedling IKS) facility in Nedre Romerike. These post-sorting facilities play a crucial role in potentially replacing the requirement for source sorting of specific waste types. For instance, these facilities can collect and sort residual waste and plastic packaging. This process

involves removing improperly sorted items and categorizing the waste into subcategories for additional waste processing. (SNL, 2023)

After sorting: Following waste collection, municipalities generally adopt two primary solutions for waste management: recycling and incineration, with landfilling being a less favored option. Figure 24 shows what happens for each type of waste. (Avfalls- og Gjenvinningsbransjen, 2016)

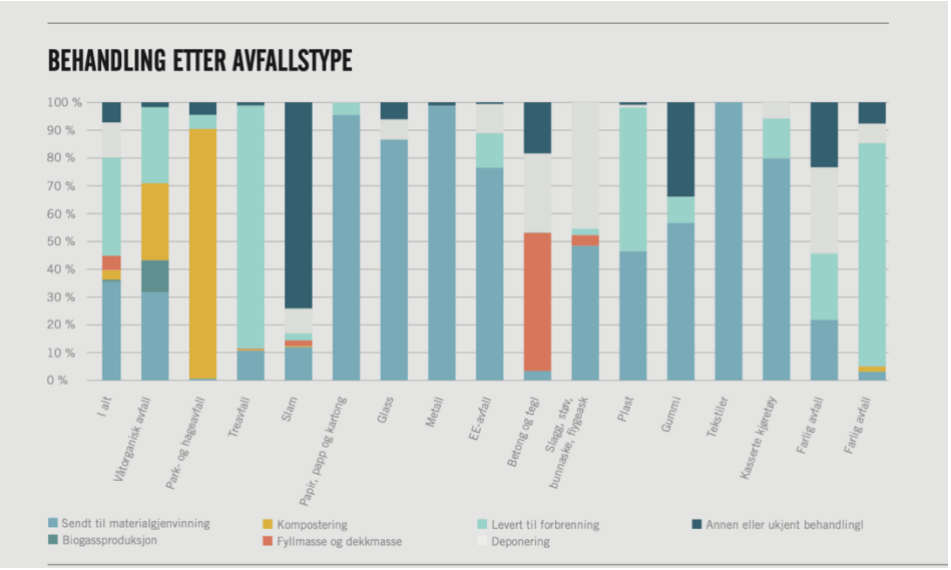

Figure 24: Treatment and Disposition of Various Waste Types in Norway (Avfalls- og Gjenvinningsbransjen, 2016)

According to reports, around 6% of the waste is directed to landfills, while the vast majority is either recycled or incinerated, the latter converting waste into energy. However, as illustrated in Figure 25, there is a forward strategy to increase recycling share to improve policies further. This strategy emphasizes increased recycling within municipal solid waste (MSW). (Municipal waste management in Norway, 2013)

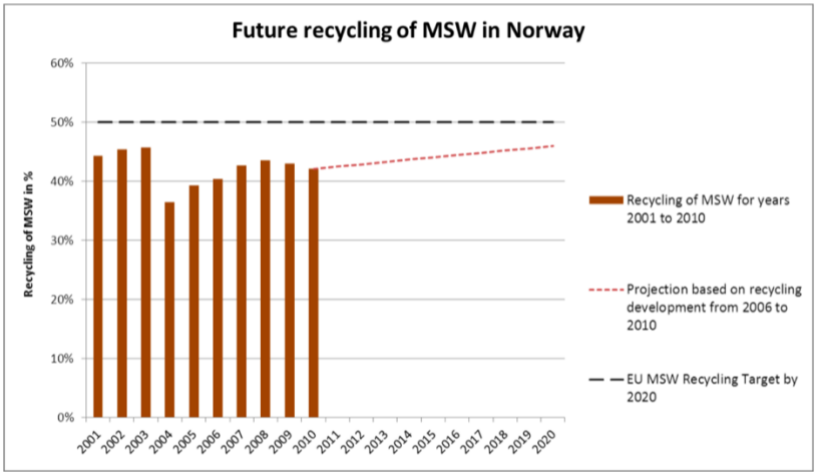

Figure 25: Future recycling of MSW in Norway (Municipal waste management in Norway, 2013)

5.2 Other Countries' solutions for cloth collecting

The data presented in this section was acquired through extensive research conducted via Google search. The study examined Denmark as a nation akin to Norway in waste management practices. Another European country, the Netherlands, was chosen as a comparative case study due to its distinct approach, aiming to evaluate its merits and drawbacks. Information and statistics utilized were gathered from published reports for accuracy and reliability.

Denmark:

The Danish textile consumption and management process involves various stages. Annually, approximately 89,000 tones of new clothing and household textiles are introduced into the Danish market, suggesting a corresponding amount of used fabrics being generated. However, only around 41,000 tones are separately collected by various charities and private organizations. From this overall amount, about 23,000 tones are exported for reuse/recycling, 12,000 tones are reused (with minimal recycling) within Denmark, and 6,000 tones are incinerated. (David Palm, 2014)

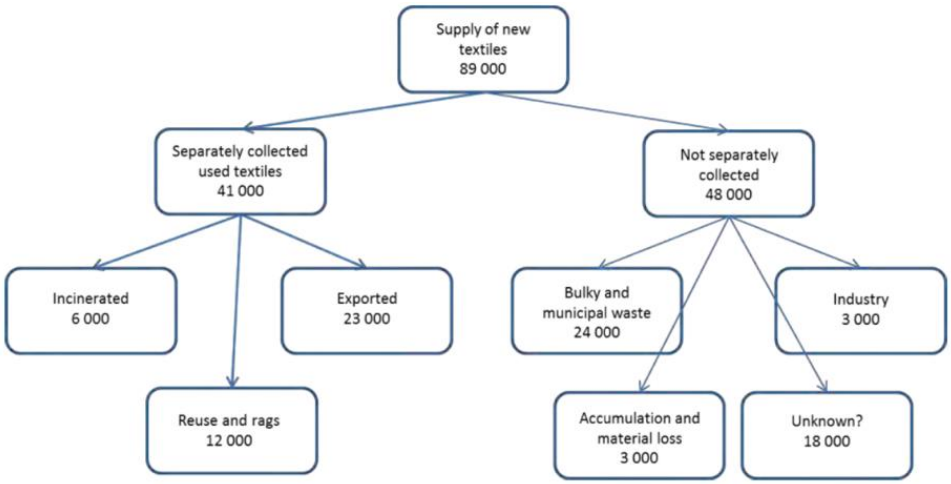

Figure 26: Material Flow of Cloth in Danmark (David Palm, 2014)

There is an estimated gap of 48,000 tones between the introduction of new textiles to the market and the amount separately collected after use, necessitating thorough consideration and analysis. Significant collectors include charitable organizations like the Salvation Army, Danish Red Cross, Danchurch Social, Trasborg, UFF, and Danmission. Beyond these, numerous miniature collectors constitute 40% of the Danish collection market, making it more diverse and competitive than other Nordic countries. (David Palm, 2014)

Collection methods range from containers and over-the-counter in organization shops to in-store drop-off boxes and luxury second-hand stores. Additionally, some brands collaborate with collectors for in-store textile drop-off. These textiles undergo varying degrees of sorting by collectors before sale, export, or further processing.

Specific organizations, like Danchurch Social, exclusively collect for resale within Denmark, while charities can sell textiles without value-added taxes (VAT) if profits are used for charitable purposes. More prominent collectors often export a substantial portion of materials for reuse or recycling in the European market. In Denmark, the recycling of textile waste is not widely available. Instead, the majority of used textiles are sold in various categories depending on their quality and level of sorting. (David Palm, 2014)

The pricing of used textiles is influenced by their quality, with varying categories and sorting levels available for buyers, ranging from unsorted batches to sorted materials based on specific agreements. (David Palm, 2014)

Netherland:

The textile collection landscape in the Netherlands has experienced changes over the years. Initially, charities handled nearly all textile collections, but by 2013, their share decreased to 55%. Recycling centers, commercial and social enterprises, and private waste companies now constitute the collection market. The separate collection of used textiles increased from 50 tonnes in 2000 to 69 in 2008 but reduced to 67 by 2014. Despite this, up to 60% of end-of-life textiles are disposed of in household waste, ending in incineration. (David Watson, 2018)

Different municipalities show varying textile collection rates, with one municipality, Oldenzaal, excelling by collecting directly from households and having a high textile container density. The Boeken, kleine Elektrische apparaten, Speelgoed, Textiel (BEST) bag system initiated by municipal-owned waste companies in two regions collects various items, including textiles, by providing a convenient method for citizens to donate or separate used goods for reuse or recycling. (David Watson, 2018)

The BEST bag system operates in seven out of eight municipalities served by Circulus Berkel, collected from the kerbside and transported to sorting centers run by Kringloop organizations. Householders in the relevant municipalities receive single-use plastic BEST bags from waste companies for storing unwanted items such as books, small electronics, toys, and textiles. They are asked to seal the bag, place it on the curbside on the collection day, and wait for collection. Each bag has a QR code specific to the household. The collection frequency varies among towns, from once every two to once every eight weeks. (David Watson, 2018)

The waste companies collect the bags according to the municipality-provided schedule. Following collection, the bags are scanned at local collection centers using QR tags to identify the households that have delivered them. These households then receive a replacement bag for the upcoming collection cycle. The collected bags are transported to three sorting centers run by Kringloop organizations, where they undergo unpacking and sorting. Some items, after potential repair, are sold in Kringloop shops. Three different Kringloop organizations operate in the municipalities managed by Circulus Berkel.

Textiles comprise approximately half of the collected items by weight. Among these, about 10% are suitable for resale in the shops, while the remaining textiles are sold to Reshare, a subsidiary of the Dutch Salvation Army responsible for textiles. Reshare resells these textiles on global markets for reuse and recycling purposes.

Trends reveal the successful collection of textiles and other goods using the BEST bag system, with a significant percentage of households using the bags. In the Circulus Berkel

municipalities, over 336 tonnes of textiles were collected in 2016 through BEST bags, showcasing citizen engagement.

The BEST bag system has been a notable initiative, facilitating efficient textile reuse and recycling while supporting social causes and citizen involvement in waste management. (David Watson, 2018)

6 Result and Discussion

The full analysis of Norway's private clothing system, particularly in the context of transitioning towards a circular economy, makes it abundantly clear that it is of the utmost significance to improve the production and consumption cycle while minimizing losses from wasted clothes. The process of transitioning is replete with challenges; thus, it is of utmost importance to recognize and solve these problems in a methodical manner. The purpose of this in-depth conversation is to go further into the myriad of issues that Norway's clothing supply chain is now facing, notably in the areas of collecting, sorting, and re-selling. Through an in-depth analysis of each component, the objective is to identify current obstacles and provide potential solutions.

Further, the challenges will be examined to clarify the impending issues. Subsequently, the current system's limitations in transitioning from a mainly linear to a fully circular system will be discussed. Finally, a rapid route will be suggested to achieve the mentioned goal based on the findings of this study.

6.1 Challenges of the Clothing System in Norway

This section addresses the key issues hindering the clothing industry's transformation to a circular economy, emphasizing three significant areas: economic, cultural, and logistical concerns. Economic issues, cultural challenges, and finally, logistical issues. These interconnected problems constitute the primary barriers to developing Norway's sustainable circular textile sector. The following will explain more.

6.1.1 Economical Problem

The Norwegian second-hand clothes supply chain relies significantly on human labor, posing a significant economic burden to the nation. Because of this dependency, significant expenses are spent, exacerbated by Norway's high labor costs. These expenses substantially influence the feasibility of collecting and processing used clothing, limiting the attraction of this option for both consumers and businesses. The fundamental challenge is maintaining the supply chain's quality and efficiency while keeping costs low.

For example, implementing the BEST BAG system requires a substantial initial expenditure, and cost recovery takes an extended period. Using this strategy also needs a complete examination of the recycling collection system. The government, municipalities, prominent institutions, and diverse companies must all contribute, which will take significant time and money. The fact that the bulk of used garments are imported and Norway lacks a large-scale manufacturing industry poses additional hurdles for recycling activities, resulting in more significant costs.

Norway's initial financial burden may be lessened via partnerships with foreign governments or charitable organizations; however, this arrangement is predicated on forming economic and political relations. Furthermore, the low resale value of second-hand clothing in Norway makes it challenging to recover expenses, particularly given the country's high labor costs. Because of the limited population and minimum order quantity (MOQ), fixed prices are higher than anticipated. This makes it difficult to make up for the tiny number of clothing acquired. Furthermore, the smaller size of sales leads to a loss in revenue.

To properly address these issues, a multifaceted approach is necessary, which may involve looking at new business models or exploring the prospect of government subsidies to compensate for high labor expenses. This method aims to effectively navigate the challenges of the Norwegian second-hand clothes business while striking a balance between economic viability and operational efficiency.

6.1.2 Issues Relating to Culture

The customer plays a vital role in the circular economy for clothes, beginning with the first usage of first-hand items and continuing via their participation in the collecting process and, finally, the purchase of second-hand apparel. One of the most important things to do to include customers in this system successfully is comprehending and influencing their behavior. In Norway, this job is met with various complex and varied cultural obstacles.

Customer attitudes and behaviors towards second-hand clothes are significantly shaped by cultural factors, giving rise to considerable impediments. Second-hand clothes are not something that Norwegian customers are particularly interested in purchasing, a trend that originates in deeply ingrained cultural views. A belief especially stigmatized in Norway's relatively rich culture is the notion that wearing second-hand garments is a sign of financial poverty or incompetence. On the one hand, there is a perception that this is the case. On the other hand, the younger generation, attracted by seasonal fashion changes and fondness for the

most recent trends, often ignores the quality and lifespan of clothing, relegating second-hand items to the status of a last-ditch choice. Consequently, the young and adult generations in Norway confront different problems when it comes to adopting second-hand clothing practices. In addition, a significant part of previously used clothing gets thrown away alongside other types of garbage, where its potential worth for reuse is not considered. About the disposal of products such as mobile phones or batteries, which are more likely to be sent to specialist recycling facilities, this stands in striking contrast to the situations described above. This gap is not attributable to the actual worth of the things; instead, it results from the consumer's impression of the convenience with which they may be discarded. In order to facilitate the development of a circular economy, it is essential to begin by establishing a sense of value within the category of throwaway clothing.

The introduction of a thorough categorization system for clothing with varied wear and tear should occur once the worth of worn clothing has been determined. Currently, the general public in Norway tends to put all unwanted clothing under the nebulous category of "waste clothes," eliminating them from the reuse cycle. This is because the general public considers the usage of second-hand clothes to be unacceptable. Establishing a domestic market and cultivating a more favorable impression of these things might be accomplished by implementing a more complex classification system that differentiates between virtually new, slightly damaged but repairable, and useless clothing. Increasing public knowledge about second-hand clothing collecting facilities and current programs for exchanging or mending these garments has to be an intrinsic element of the government's activities.

Consumption, defined as the generation of more trash than the average lifetime of garments, is another key concern in the context of Norway. Although some of this consumerism may be ascribed to the fact that worn clothing can be thrown away so easily, a more in-depth investigation finds that cost and aesthetics often precede quality and durability in consumer selections. The lifetime of clothes might be increased by encouraging the import and manufacturing of higher-quality clothing that is produced from long-lasting materials such as linen or cotton rather than nylon, which is composed of components of inferior quality. This would also make recycling and reusing garments more possible and cost-effective.

In order to effectively address these cultural difficulties, a multi-pronged strategy is required. This involves the dissemination of information, the conduct of awareness campaigns, and the advertising of sustainable fashion as a cultural standard. It is possible to improve cooperation within the clothing system by drawing attention to the economic and environmental advantages of circular practices, supporting sustainable fashion influencers, and cultivating a community

centered around efforts related to circular economies. The cultural narrative may be shifted toward a more sustainable and circular approach to fashion via the implementation of educational efforts and awareness campaigns, which can play a crucial role in changing consumer opinions regarding clothing purchased from thrift stores.

6.1.3 Obstacles related to logistics

In terms of logistics, the great geographical spread of Norway, in conjunction with its relatively tiny and scattered population, poses a unique set of obstacles when collecting used clothes. This phenomenon is more prominent in more rural and smaller communities, where collection sites are sparse and often confined to drop-off places. Consequently, the articles gathered are limited in diversity, and a significant number of clothing that may be reused are not included. Furthermore, because of the limited population size, the fixed expenses of recycling and processing these garments are dispersed among a smaller number of individuals, which renders the procedure economically unviable. In addition, since Norway does not have any recycling facilities, it is necessary to export worn clothes for recycling purposes. This results in extra expenses because of the extensive distances required to ship to other countries. When it comes to logistics, enhancing the effectiveness of the collection network and maybe developing local recycling facilities might help reduce the issues that are associated with both the economy and the logistics. In the subsequent section, further details will be explained on this matter.

In conclusion, while the transition to a circular economy in Norway's personal clothing supply chain involves a number of problems, recognizing and carefully resolving these concerns might pave the way for a system that is more sustainable and feasible from an economic standpoint. To contribute to the overarching sustainability objective in the fashion industry, future research can concentrate on developing certain techniques and models that can be used to solve particular issues.

6.2 Reflection and pros and cos to Circular clothing system in Privat cloths

Throughout this extended research effort, the major objective was to answer the essential queries disclosed in section 1.4. This was done to ensure that our study followed a logical development. According to the information presented in section 1.1, Norway is a noteworthy example of a country that consumes a significant amount of high-volume apparel consumption.

The proposed solutions are divided into two fundamental categories to facilitate the transition of the clothing industry towards circularity, as outlined in section 3.3.1. The first category is design-oriented solutions that emphasize the utilization of superior raw materials to enhance durability and facilitate recycling and post-production strategies that aim to establish an efficient system for clothing collection and reintegration into the production cycle. A startling 99% of the clothing consumed in Norway is imported, as discussed in section 4.1. This results in the dominating linearity of the clothing system in the nation, with just a measly 20% of the clothing being returned to the using cycle; then, the first solution is not reliable here.

The second category is post-production solutions that are suitable for Norway. The next part will focus on the difficulties experienced throughout the post-production phase.

According to the information presented in section 4.1, out of the small percentage of twenty percent that ultimately return to the manufacturing cycle, a significant proportion of eighty-six percent finally return to the clothes production system. On the other hand, a scant sixteen percent is either thrown away or recycled. This gap exposes a tremendous unrealized potential, where about eighty percent of the wasted clothing provides a chance for reintegration that should have been taken advantage of.

Regarding reusing, only a small amount is sold inside Norway, while most of it is sent to destinations in Eastern European countries.

Therefore, suggest an applicable solution for Norway regarding all the existing challenges and prominent needs to create a step-by-step guide from the baseline of creating waste cloth to its final destination and possible difficulties in each step. In this guide, to better understand the difficulties, we have divided them into three primary categories: those linked with collecting, sorting, and repairing/re-selling.

6.2.1 Collection from individuals living in their homes

In this step, we have two actors to focus on. First, consumers who need to deliver their waste cloth and collectors to retrieve these used clothes for further processing.

In the case of consumers:

Increasing public knowledge about the environmental and economic advantages of collecting worn clothes is crucial for the consumer sector of the circular garment economy. This may be

accomplished by initiating a complete advertising effort founded on scientific research. One thing that has been discovered is that the general population of Norway needs to be made aware of the worth of old garments and the possibility of reuse that they possess. The common belief that worn clothing is worthless is a consequence, leading to a lack of engagement in the many collecting activities already in place.

The infrastructure that is already in place for the gathering of garments has several limitations. Because there are so few drop-off places, people often only bring in clothing that is in pristine condition when they make their donations; items of clothes that are just slightly damaged or may be repaired and are still suitable for reuse are not included in this practice. The problem is more conspicuous in smaller towns, with fewer collection facilities. As a result, it is necessary to reevaluate the system's cost-effectiveness and accessibility in order to tackle this problem effectively.

Wet municipal garbage is now being used to dispose of a significant amount of the clothing that is being discarded. During the fifth section of our investigation, we analyze the well-established infrastructure municipalities have in place for collecting domestic garbage. This infrastructure presents an opportunity to include clothes containing within this framework. The utilization of this infrastructure for the recovery of clothes offers a number of advantages, including the enhancement of accessibility and the inclusion of the capability for persons to get rid of garments that they feel to be unneeded. Municipal authorities or charity groups might work together to supervise the post-collection segregation of things. Both of these options are feasible.

It is vital to provide a change in attitude in order to encourage increased public collaboration in gathering garments. The establishment of a social movement for the circularization of the garment sector is one of the most essential advantages that can be gained from increased public knowledge. This movement is beneficial in terms of cultural and collecting elements, as well as the economic realm, perhaps via donations from the general public or contributions made by volunteers to contribute. An essential initial stage in the strategic process is to make use of social media platforms, which are particularly popular among younger generations. The use of influencers on social media platforms such as TikTok, YouTube, Instagram, and Twitter, in conjunction with the dissemination of posters, placards, and targeted television advertising, has the potential to impact the perceptions and actions of the general population significantly.

At subsequent stages, the emphasis should be placed on the implementation of incentive programs at educational institutions as well as the creation of content for children and charitable organizations in order to fuel this movement. Once a substantial cultural movement has been developed, implementing mechanisms that allow for the exchange of old and new clothing may serve as an additional incentive for active engagement. On the other hand, if these replacement programs are implemented too soon, they run the danger of being abused for profit rather than used to cultivate a culture of sustainability.

In the event that the cultural basis for clothing collecting is established, the attention will next move to the categorization and organization of the garments that have been gathered. During this phase, it is necessary for the public and organizational entities to work together in order to establish a categorization system that is both cohesive and useful. This framework will be described in further depth in section 6.2.3.

In conclusion, the change in the culture around clothing collections depends on the combination of scientific advertising methods, improvements to infrastructure, and a significant shift in the behavioral and perceptual patterns of the general population. After the formation of this culture, the position of collectors has become very important since they are responsible for supervising the categorization, sorting, and redistribution of the clothes that have been gathered.

In the case of collectors:

The difficulties linked with the collection of recyclable clothes in Norway are diverse.

The first reason for these issues is the low amounts of clothes some organizations accumulate, which results in high transportation and collection costs. This is because of the low population in Norway, and a number of institutions are involved in the collecting process, making coordination more difficult with gathering the low amount of cloth for each organization and having. Another reason for the low number of clothes collected is the people's low participation; since Norway, as mentioned, is one of the countries with a high per capita consumption, it should contain more clothes from the people. A potential solution to this problem involves implementing a discount coupon system whereby various discount coupons are provided to individuals based on the frequency of their clothing donations. In addition, we can use many charities that collect clothes to manage certain metropolitan regions or places; charitable organizations have to work together, maybe on a predetermined timetable. The charity may have a branch in a big city with a high number of containers. It might take responsibility for less populated towns that do not have containers, thereby reducing the

amount of extra expenditure. It is recommended that these institutions work together to establish a single collecting system, with the government intervening if there are differences in the worth of the products.

In addition, a clear differentiation is imperative to differentiate themselves from municipalities that frequently do not collaborate with charitable organizations and lack a specific collection strategy for this sector. Because the municipality does not have a place to collect clothes and charity centers only collect clothes that can be reused, people throw most of their clothes that they think are not good together with other garbage. The result is that a significant amount of these materials is often assigned to the burning process. Therefore, it is vital to have a clear division of duties. In order to solve this issue, strategically positioning these facilities, maybe in close proximity to authorized containers and ideally underground, can protect the quality of the garments. Since it is crucial for clothing containers to be designed to prevent moisture ingress, ensuring that the quality of the clothes remains intact. Also, special plastics can be given to people for packing clothes so that their quality does not decrease during the transfer process. In this system, we can use different colors for different types of clothes. A further approach would be for the municipality to implement a system similar to collecting hazardous waste. This would include households depositing their clothing for collection on a biannual basis, but the operating costs would be more significant. This is something that is discussed in section 5.2 about the Netherlands. For better cooperation with charity centers, the government can collect clothes of lower quality and charity centers of high-quality clothes.

Lastly, each institution may distribute the clothing gathered in a manner that was thought appropriate, with the government providing incentives for the domestic sale of wearable things. Under the supervision of the government, clothing that is no longer usable might be shipped overseas for recycling. The implementation of this recycling project has the potential to boost local output, particularly in more distant and smaller locations, thus contributing to economic development and lowering migration.

To summarize, the problem of clothing collection in Norway calls for a coordinated strategy involving towns, charitable organizations, and maybe the government. This would allow for increased collection efficiency, decreased expenses, and more recycling, which would eventually benefit the economy and the environment.

By bridging the gap between charitable and municipal efforts, improving logistics, and increasing cloth quantities for resale and recycling, this integrated method that has been offered has the potential to revolutionize clothes collecting. However, it is important to note that factors

such as infrastructure, quality maintenance, and operating expenditures must be taken into account.

6.2.2 Sorting the Cloths

One of the most critical steps in collecting clothes is the sorting phase, which involves carefully classifying the items that have been acquired. If the situation demands that the duties be divided between charities, the first step should be to unify and standardize the grading of second-hand clothes. In this section, a 3-part and preferably 4-part grading should be done first. Considering the general quality of the clothes used, these four divisions can be suggested. First: Clothes that can be used or resold without any secondary operations. These clothes can be clothes with particular brands or sleepwear and the like. (Except underwear that is sent directly for recycling, the type of clothing does not affect its grading; only the physical condition of the clothing will determine its grade) The third category is clothes that have significant tears and must be discarded. All the clothes that cannot be used inside or outside the country are placed in the fourth category for recycling. To do this category, the classification must be done by a person with sufficient knowledge or experience in the classification of each institution present to reduce the possibility of future problems as much as possible.

After doing this classification at the institutions, what is important is to determine the fate of each group of clothes. According to the diagnosis, the first category can be sold at the place of the same charities in order to reduce the manpower and secondary equipment. For example, as some institutions set monthly collection programs in specific places, they can also sell the same set of clothes seasonally or annually in the same places where the residents are already familiar with its charity function.

The second category comprises clothing components that can be reused with minor repairs but are otherwise unusable without such interventions. These clothes, including jackets with unbuttoned buttons or open seams, can be sold with minimal cost and time. For this sector, with the cooperation of the government, assistance programs can be created for disabled people, retirees who are inclined to work, people with a history (returned to the road), or those who have been sentenced to perform social services. Besides bringing another part of the society into this cultural movement, this division of duties can also restart some families' stopped economic cycle. On the other hand, since sewing and repairing this part of clothes does not require much time and skill, it can be done on-site and periodically. After repairing these clothes, they can be put up for sale again in the same monthly or yearly plans.

The third category is clothes that need more skillful tailoring. Considering their physical condition, these clothes will need to be transferred to a secondary place for repair and disposal. Furthermore, in this section, groups in need of employment, requiring assistance, and individuals sentenced to perform social services with sewing expertise can be effectively engaged. In this department, sewing experience will be the first requirement for employment. The last batch will be grouped and sent to a central point to decide its outcome. More explanations will be provided in the next part of the relationship with this category.

Considering the problem that checking the quality is a matter of taste, it should be considered that this rating can be a big challenge in this program. As a result of this, in order to make this classification uniform and standardized, it is necessary to carry out a comprehensive and detailed investigation of the types of clothing and the damage caused to it so that all institutions serve in this sector in a coordinated manner, If, instead of institutions, the municipality (public sector) takes over the duty of collecting and confiscation. One of the ideas that can be done is if the economic value of this process increases. Point classification and regional restoration. In such a way, the clothes are classified in the place of each city, but the clothes of the second and third categories are sent to specific areas of the country for repair. This regional restoration can be one of the ways to create unique economic markets in less industrialized parts of Norway.

If, after the annual period of carrying out this plan, the economic numbers are not the same or close to the estimates of the initial plan, it is possible to consider using other countries as the division area in the second stage. In such a situation, however, the resale of clothes will no longer be a national priority. Because the cost of sending all the collected clothes and ensuring the related costs will be much higher than the return of the price generated from the sale of the first and even the second batch if it does not have the benefits of cultural load and domestic economic rotation. Nevertheless, in any case, what is decisive will be the annual performance of the executive institutions after the set period.

When it comes to Norway, this crucial step is confronted with a number of solid obstacles that hinder its efficiency and effectiveness. The prohibitively high cost of labor is the most significant of these complications. These organizations that are engaged in clothes collecting have a substantial financial burden due to the expenditure made during the sorting process, especially in terms of physical labor. This makes it economically challenging for these organizations. The idea of moving all of the sorting and repair activities to a nation in Eastern Europe is one possible option that may be considered. In light of the fact that these locations account for a significant share of the total cloth sales, a transfer of this kind might drastically reduce expenses. The labor-intensive sorting and repair operations may be carried out in

Eastern Europe because of the comparatively cheaper labor costs available there, making it financially feasible. Through the process of offshore these activities to places where labor costs are more affordable, there is the possibility of significantly reducing the effect on the environment while also generating job possibilities; however, there are a number of challenges here because sorting is based on human dictated it may happen the sorting in a different group of cloth and quality of each group changed, second the cloths that chosen to send Norway is not suitable for Norwegian taste.

6.2.3 Repairing and Reselling and Recycling

By the aforementioned categorization, garments will either be sent immediately for sale, or after undergoing minor repairs, they will be available for sale; or after undergoing a comprehensive refurbishing, they will be able to be sold at a lower price; and lastly, the fourth category will be sent straight for recycling. It should be brought to everyone's attention that to maintain the integrity of the economic cycle, sending the fourth category to be burned is unacceptable.

The market for used clothing is fairly limited in Norway, in contrast to Eastern European nations, where the market for used clothing is both extensive and prospering. This gap may be attributable to a number of different variables, one of which is the absence of a well-established culture of second-hand clothing in Norway. Additionally, a massive distinction is that people in Eastern Europe buy clothes because it is more inexpensive than in other parts of the world.

On the other hand, it is of the utmost importance that we change our attitude with respect to the purchase of used clothing. Instead of considering second-hand clothes as just a cost-effective alternative, it is essential to reframe the narrative to emphasize the positive effects of second-hand clothing on the environment. The view of second-hand clothing may be altered if we emphasize the environmental benefits connected with it, such as the reduction of textile waste, the conservation of resources, and the reduction of the carbon footprint directly related to the creation of new clothing.

At the same time as the environmental advantages of shopping for used products are being emphasized, Norwegians are being urged to regard shopping for used items as a proactive step towards a more sustainable lifestyle. A culture of responsible consumerism is fostered via the

implementation of this strategy, which encourages individuals to make decisions that are advantageous not just for themselves but also for the environment. It is possible to develop a more profound appreciation for the role that second-hand clothing plays in supporting sustainability by first understanding the more extensive influence of these decisions.
The younger generation has to be more actively engaged, and there is an urgent need to bring attention to the advantages of platforms that sell used clothes, particularly those that are available online. We are able to encourage more people to participate in the second-hand clothing trade by highlighting the environmental advantages, the affordability, and the one-of-a-kind fashion treasures that are accessible in these marketplaces.

The second significant factor to take into account is the need for a wider diversity and creativity in the selection of second-hand clothes made available in Norway. In order to address this issue, a multifaceted approach is required, which may include the consolidation of the collection of worn clothing, followed by comprehensive repair and refurbishing techniques. There is a possibility that this may result in a greater selection of clothing alternatives being made accessible, which will appeal to a larger audience. For this particular one, we may get assistance from students who have studied fashion to replace outdated clothing with new clothing suitable for today's trends.

Reconsidering the positioning of second-hand clothes stores, which are now situated mainly inside communities and have a limited volume of foot traffic, is the third element to consider. The relocation of these establishments to high-traffic locations, such as shopping malls, in close proximity to well-known brands and retail businesses has the potential to improve their visibility and accessibility dramatically. Second-hand clothing has the potential to become much more appealing to customers in Norway if this strategic repositioning is implemented.
Keeping in mind that the maintenance of a circular consumption and recycling system inside the nation is a priority, garments that need more extensive repairs might be sent straight to an external agency or countries with weaker economies. This would be the case, given that the combined cost and return value would not be lucrative.
Given that there is no domestic textile recycling system, a partnership with a secondary nation is required to fulfill the fourth category's requirements. There are two primary choices available: either the complete recycling and reuse system may be outsourced to a different nation (such as Eastern Europe or third-world countries), where labor and energy prices are lower, or the facilities of these countries can be used as a return bridge. In the second scenario,

the raw materials would be returned to Norway after being recycled as part of the process. This may include selecting towns or areas that have had less industrial expansion as manufacturing bases for domestic clothes.

Because a significant portion of the clothing thrown away in Norway is composed of nylon and other materials of a similar kind, it would be good to conduct a survey of nations that recycle these types of clothing.

To summarize, tackling the issues of clothes collecting and recycling in Norway requires a complex and coordinated strategy that highlights the responsibilities of both consumers and collectors.

Consumer views and habits must be changed via extensive awareness efforts emphasizing the environmental and economic advantages of recycling clothing. This includes improving current clothing collecting infrastructure, leveraging municipal garbage systems, and developing a societal movement toward a circular garment business. This cultural transition may be aided by the use of social media influencers and targeted advertising, as well as instructional campaigns in schools and charities. Furthermore, rewarding the public via initiatives such as clothes exchange and discount coupons might promote more active engagement.

To solve the complexity of recyclable clothes collecting, collectors must address challenges such as low collection volumes, high transportation costs, and the need for greater cooperation among diverse organizations. Efficiency may be improved by strategies such as uniform collecting methods, collaborative efforts between municipalities and charities, and a clear separation of responsibility. Color-coded packaging for various textile grades and smart positioning of collection locations may improve the quality and quantity of collected clothing. Furthermore, given Norway's high labor costs, investigating the idea of outsourcing sorting and repair tasks to nations with lower labor costs might be a cost-effective alternative. However, careful consideration of quality standards and cultural preferences is required.

To achieve consistency and efficiency, the sorting step, which is critical in collecting, necessitates a defined grading system for used clothing. This method should classify clothing according to its condition and appropriateness for resale, repair, or recycling. Collaborative activities engaging many socioeconomic groups in repairing and selling these items may solve not just economic difficulties but also contribute to social inclusion and community participation.

Finally, given Norway's lack of a domestic textile recycling system, recycling unsalable clothes demands collaboration with nations with the requisite infrastructure. This technique may help ensure environmental sustainability while also possibly contributing to economic progress in less developed places.

Overall, Norway can improve its garment recycling efforts by bridging the gap between consumer participation and effective collecting techniques, as well as by solving sorting and recycling issues in novel ways. This integrated strategy not only promotes environmental sustainability but also adds to the country's economic growth by encouraging responsible shopping and environmental care.

7 Limitations and Further Work

This part will give insight into the constraints observed throughout this study and recommend future avenues for investigation.

7.1 Limitations

Within the context of providing a complete view of the breadth and significance of this study, it is vital to investigate the limits and implications of this research. This study's primary objective was to investigate the material flow of clothes, and it did so by applying qualitative research methods that provided significant insights into the lifetime of clothing. It should be noted, however, that these approaches needed to be improved, especially regarding the complexity of financial matters and cost evaluations.

Cost analyses: Although qualitative approaches helped comprehend the nature of material flow, it is possible that they could not adequately address the financial complexities and cost-related variables that are involved in the apparel lifecycle. Future research endeavors may consider incorporating quantitative studies to provide a more comprehensive understanding of the economic aspects of the circular economy of the garment sector.

The Recycling of Fabric and the Development of Current Technologies: In the study, the difficulties associated with recycling fabric were investigated in great detail (as was mentioned in section 3.3.2). On the other hand, it needed to fully investigate the possible ramifications that may arise from the development of technology in this area. The fabric recycling technologies are progressing quickly and show tremendous promise for the transformation of recycling procedures. Despite the fact that this technology aspect was beyond the immediate subject of this study, it is still essential to highlight the possible influence that it may have. Subsequent research needs to take into consideration doing a more in-depth investigation into the ways in which new technologies have the potential to revolutionize the recycling of fabrics and improve circularity within the garment industry, which we mentioned in summary is not applicable in Norway.

Data Sources: The research relied primarily on secondary data sources, gathered by conducting exhaustive searches in public repositories. Despite offering a broad spectrum of information and being obtained from reputable sources, these secondary sources were naturally subject to certain constraints.. There is a possibility that secondary data may not always be the most recent, thorough, or exhaustive, which may have an impact on the level of depth and

accuracy of the conclusions of the study. It would be beneficial for future studies to use primary data-gathering techniques in order to supplement the information that is already available and to guarantee the accuracy of the data. However, it is worthy to mentioned, one part of this study that is encouraging is Norway's dedication to enacting regulations that promote openness. Because of these rules, individuals will have access to legitimate data and helpful resources from reputable institutions. Utilizing this transparency not only helps to improve the dependability and trustworthiness of the conclusions of the research but also makes a contribution to the robustness of the study. This dedication to openness contributes to an increase in the overall effect of the study, which is beneficial in both academic and practical settings.

In conclusion, despite the fact that this study has made major contributions to understanding the material flow and issues within the circular economy of the garment sector, it is vital to acknowledge the limits of this research as well as the prospective topics that may be explored in the future. In order to further improve the basis of knowledge in the quest for a more sustainable and circular garment business, it is necessary to address these restrictions and embrace future technology.

7.2 Further work

There are several areas that need additional examination in order to get a more thorough knowledge of the circular economy of clothes; yet, the research that has been undertaken up to this point has offered considerable insights into the topic. For example, one of these areas is the comprehensive examination of the present costs associated with the apparel cycle and the prospective fluctuations in those costs. A more in-depth investigation of the financial elements of garment collecting, sorting, recycling, and redistribution will provide valuable insights regarding the economic feasibility and sustainability of circular processes in the fashion business.

A Comprehensive Cost Analyses: There is an absolute need for a more in-depth investigation of the present expenses that are involved in the various phases of the apparel cycle. This involves determining the costs associated with the personnel, transportation, processing, and technology used at the facilities responsible for collecting and sorting. If you thoroughly understand these prices, you will gain better insight into the financial obligations and rewards associated with each step of the circular apparel production process.

Expense Trends for the Future: It is equally important to investigate the possibility of variations or patterns in these expenditures over time. In order to do this, it is necessary to investigate the ways in which the total cost structure of the circular fashion industry may be affected by changes in market dynamics, labor prices, technology improvements, and environmental legislation. Examining these tendencies will assist in anticipating the economic viability of circular processes within the fashion industry over the long run.

Application of Automation in the Separation of Clothing and Recycling Automation Technologies: Even though the study only touched on the topic of automation in textile separation and recycling for a short moment, it is imperative that more investigation can be conducted into this field. It is essential to have a solid understanding of the present status of automated technologies in the apparel business and their potential for the future. Among these methods is the evaluation of the many kinds of accessible technologies and their capabilities and limits. However, it is essential to thoroughly investigate the ramifications of integrating automated technologies when they are implemented. Evaluating the influence that automation has on cost efficiency, processing time, labor needs, and environmental sustainability is a necessary step in this process. Automated sorting systems, for instance, have the potential to cut down on the amount of human labor required dramatically and speed up the sorting process. However, these systems may need considerable initial expenditures and ongoing maintenance expenses.

Policy and rules: This study has the potential to make a substantial contribution to the current debates and improvements in sustainable fashion practices. This might be accomplished by performing an examination of the economic and technical components of the circular garment industry that is more comprehensive and detailed. This kind of study would not only improve our knowledge of the present condition of the circular economy in the fashion sector, but it would also offer us vital insights into the potential for long-term sustainability and the future directions that the economy is potentially heading in.

8 Conclusion

As we get to the end of this extensive thesis, we dig deeply into the myriad of possibilities and obstacles inherent in transforming Norway's private clothing system towards a circular economy. This broad investigation not only investigates the complexities of clothing consumption and waste management, but also investigates the practicability and implementation of sustainable methods within the specific context of Norway. Overall, this investigation is relatively comprehensive.

The Most Important Obstacles and Opportunities:

1- **High Per Capita Clothing Consumption:** Despite the fact that it is a reflection of Norway's richness, the country's distinctive trait of having a high per capita clothing consumption greatly compounds the difficulties associated with transitioning towards a circular model. Due to high consumption rate, there is a comparable amount of clothing waste, which calls for management that is both ecologically responsible and sustainable.

2- **Logistical Difficulties:** The thesis discusses the logistical difficulties that include collecting and sorting garbage, which is an essential component in the process of transitioning to circularity. In order to successfully reintegrate these materials into the manufacturing cycle, it is essential to have efficient methods for collecting, transporting, and sorting discarded clothes. Given Norway's geographical spread and demographic distribution, these procedures call for major financial expenditures as well as strategic planning.

3- **The Behavior of Consumers and the Participation of the Public:** Consumer behavior has been highlighted as a significant aspect that plays a key role. Awareness and engagement from the general public are integrally tied to the transition toward a circular economy related to clothes. It is vital to change consumer behaviors, beginning with the purchase of apparel and ending with its disposal. To achieve this, it is necessary to cultivate a culture that promotes the responsible disposal of clothes and circles of consumption. This may be accomplished through the implementation of specific educational and awareness programs.

Approaches to Strategic Problem Solving and Proposed Solutions:

1- **Development of Efficient Collecting Systems:** The thesis suggests the creation and deployment of collecting systems that are both more efficient and more easily accessible. This involves constructing broad collection stations and integrating these systems into existing frameworks for municipal garbage managemen
2- **Incentives for Consumer Participation:** It is of the utmost importance to ensure that consumers are encouraged to participate via incentive schemes. Discount coupons for safe disposal and awards for buying recycled or sustainable apparel are two examples of the kinds of incentives that might be taken into consideration.
3- **Collaborative Efforts between Stakeholders:** A strategy that is coordinated and involves a variety of stakeholders is essential. Collaboration is required between municipalities, charitable organizations, government authorities, and the commercial sector in order to guarantee a seamless transition to a circular model. This includes the formulation of policies, the establishment of standards, and the formulation of comprehensive guidance for both consumers and enterprises.
4- **Incorporating circular economy concepts:** In order to incorporate circular economy concepts into the clothing business, it is necessary to rethink the full lifespan of clothing goods. The sustainability aims must be linked to each step, beginning with the design and continuing through manufacturing, usage, and disposal. The promotion of the use of sustainable resources, the encouragement of recycling and upcycling, and the reduction of waste at each level are all included in this commitment.

Implications for the Long Term and Directions for the Future:

According to the information presented in this thesis, the process of establishing a clothing system in Norway that is both sustainable and circular is not only difficult but also provides an opportunity that is of great value. This transformation has the potential to address urgent environmental challenges and deliver economic advantages by fostering the development of new sustainable practices and companies.

The insights and methods detailed in this study provide a major contribution to the ongoing conversation taking place all around the world about environmentally responsible business practices in the fashion industry. This thesis establishes a precedent in Norway, which paves the door for other countries to model their procedures after Norway's and adjust them to fit their own circumstances.

Ongoing research, innovation, and the formulation of new policies are essential steps for the future. This includes the development of new textile recycling technologies, exploring cost-effective circular practices, and investigating the global impact of implementing such models.

In conclusion, this thesis not only offers a comprehensive examination of the present condition of Norway's clothing system, but also serves as a plan for converting it into a sustainable and circular model. Not only are the ideas and tactics that have been offered applicable to Norway, but they also provide vital insights into the worldwide effort that is being made to make the textile sector more sustainable and ecologically aware. Even though the path that lies ahead is difficult, the potential benefits that it might bring to society, the economy, and the environment are enormous, which makes it a quest that is deserving of continuous effort and attention.

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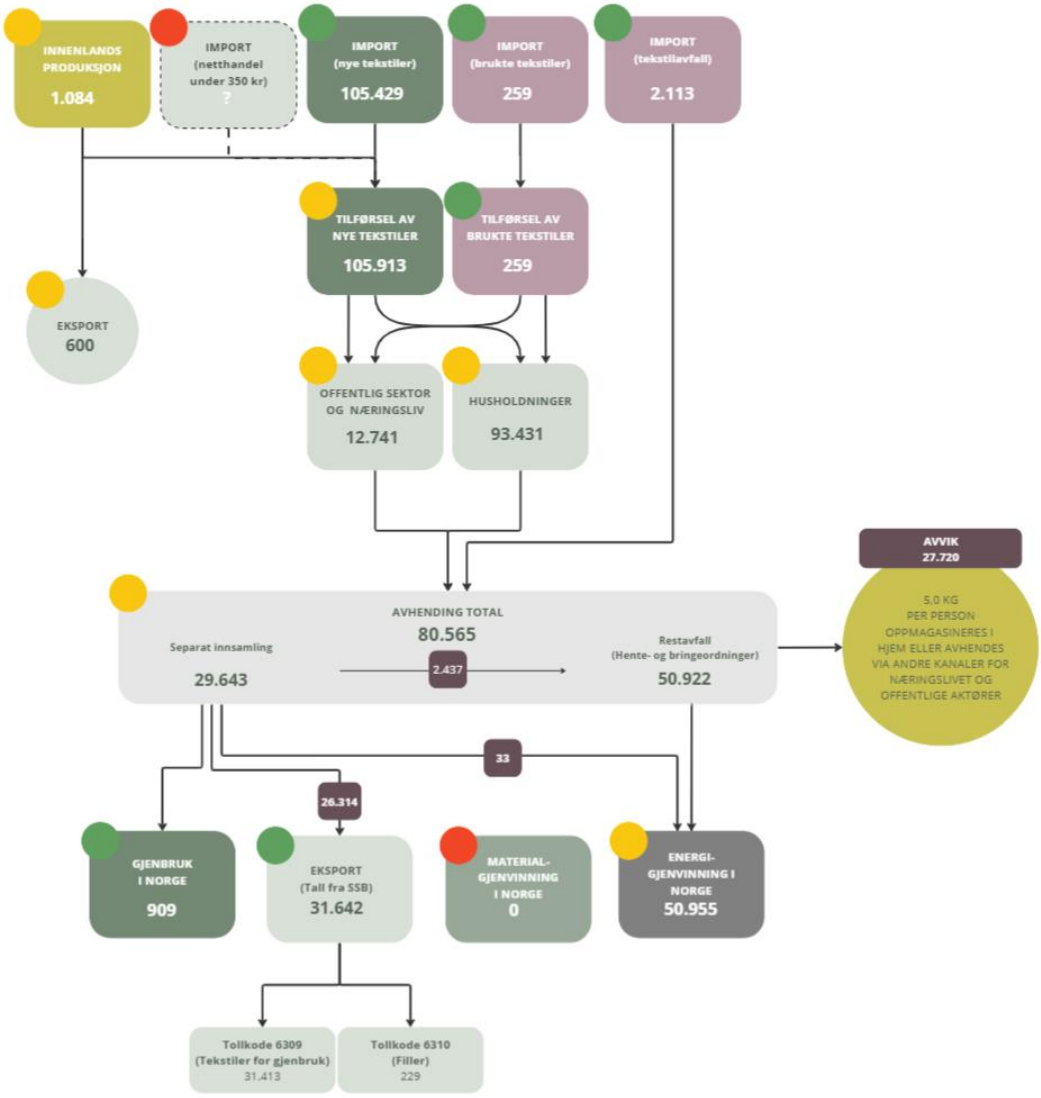
Appendix A

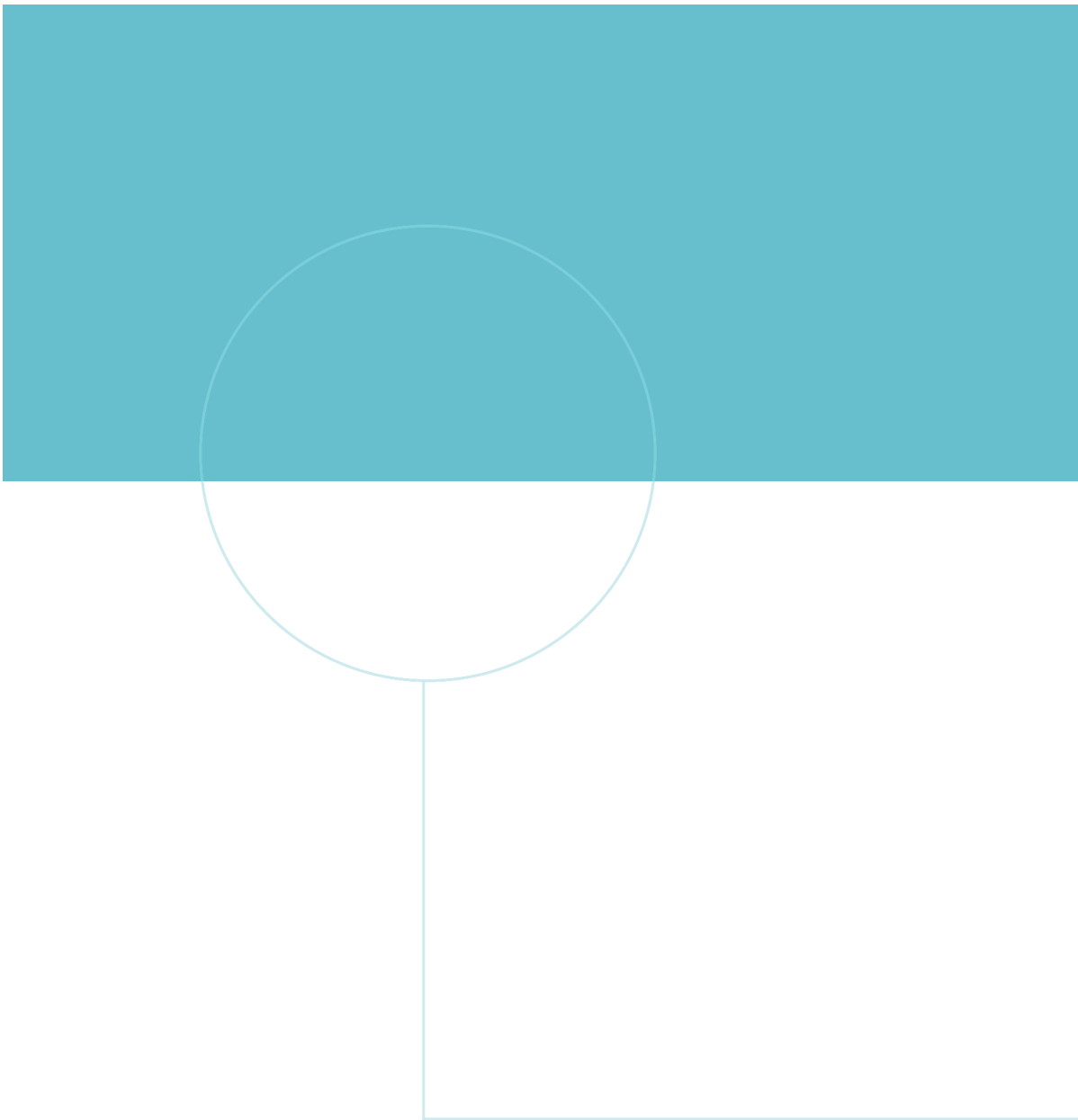
Overview of material flow of clothing in Norway



Appendix B

Overview of material type of waste clothes from SSB in 2022

Fibertype/materiale	Tonn	%
Bomull	25 395	28.78
Syntetiske/kunstfiber	22 554	25.56
Bare oppgitt som trikotasje, tekstil etc.	20 478	22.72
Plast	10 621	12.04
Lær	6 576	7.45
Ull og fine dyrehår	2 891	3.28
Pels	103	0.12
Silke	46	0.05
Lin		0.00
Total	**88 233**	**100%**



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