TALLINN UNIVERSITY OF TECHNOLOGY
SCHOOL OF ENGINEERING
Department of Mechanical and Industrial Engineering

ESTONIAN ACADEMY OF ARTS
FACULTY OF DESIGN

MSc. Design and Technology Futures

OPPORTUNITIES WITHIN SUSTAINABLE GARMENT TECHNOLOGY: IMPROVING GARMENT LONGEVITY AND REUSE CYCLES THROUGH AN ADJUSTABLE FITTING MECHANISM

JÄTKUSUUTLIKU RÕIVATEHNOLOOGIA VÕIMALUSED: RÕIVASTE PIKAAEGSUSE JA TAASKASUTUSTSÜKLITE PARANDAMINE LÄBI KOHANDATAVA ISTUVUSE MEHHANISMI

MASTER THESIS

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Tallinn 2022

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Opportunities within sustainable garment technology: improving garment longevity and reuse cycles through an adjustable fitting mechanism

supervised by **Ruth-Helene Melioranski and Kirsi Laitala**

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THESIS TASK

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Thesis topic:

Opportunities within sustainable garment technology: improving garment longevity and reuse cycles through an adjustable fitting mechanism.

Jätkusuutliku rõivatehnoloogia võimalused: rõivaste pikaaegsuse ja taaskasutustsüklite parandamine läbi kohandatava istuvuse mehhanismi.

Thesis main objectives:

1. Research the state of the current sustainable fashion system.

2. Identify innovation and further development needed to elongate garments' lifespan and increase the potential for reuse.

3. Engineer a garment and map a system which will change how garments are manufactured, used, and reused.

Thesis tasks and time schedule:

No	Task description	Deadline
1.	Qualitative Research	28 February 2022
2.	Literature review	7 March 2022
3.	Concept Exploration	18 April 2022
4.	Prototyping and Testing	09 May 2022
5.	Evaluation and Conclusion	19 May 2022
6.	Thesis Finalisation	23 May 2022

Language: English   **Deadline for submission of thesis**: 23 May 2022

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ABSTRACT

The current discussion around sustainability concentrates on concepts of circularity and sustainability from operations, energy, garment-textile choices and innovations, manufacturing processes, and business models. However, the lack of focus in the discourse on garment usability properties, such as fit and suitability for reuse, leaves unexplored aspects of sustainability with substantial potential impact on garment disposal, i.e., reasons why consumers discard garments. In addition, garment technology research on aspects of garment fit (how an item of clothing fits the body of a given consumer) as a sustainability strategy remains insufficiently researched in fashion sustainability studies.

This study combines systems thinking with garment technology to view the physical garment route in the fashion system. The thesis uses qualitative research methods such as interviews with different stakeholders involved in various stages of the garment lifecycle. This is reinforced by a review of the literature on sustainable fashion, reasons for clothing disposal, and different sustainable strategies for improving and elongating a garment's lifespan.

The thesis makes a case for the importance of the system need to include the concept of garment fit in discussions around sustainability. It considers various factors driving garment disposal to improve the odds of garment longevity through recirculation and reuse.

What follows offers a solution for elongating garment lifespan for single and multi-user through analysing leverage points in the fashion ecosystem to identify potential improvements in concern with garment development. This study thus aims to offer a holistic approach and adaptive models for new approaches to sustainability for the fashion industry.

Keywords: Garment technology, systems thinking, garment fit, sustainable strategies, fit adjustability, garment disposal, consumption models, reuse cycles, master thesis.

TABLE OF CONTENT

List of abbreviations and symbols

CE   - Circular economy

DIY   - Do It Yourself

EU   - European Union

MOQ   - Minimum Order Quantity

PSS   - Product-Service System

1 INTRODUCTION

Fashion is a vast system tied into all aspects of everyday life and essential for economic prosperity, worldwide employment, and personal development and expression. Due to cultural expectations and weather conditions, body covering is essential to most populations. Moreover, all humans connect with the system by wearing clothes, experiencing culture through appearance, or actively participating in the industry. However, fashion is also one of the most significant contributors to environmental damage (Ellen MacArthur Foundation, 2017; Niinimäki, et al., 2020). The wide scope and integrated ways of connecting fashion with different industries are one of the most significant economic drivers. Fashion's environmental impact is on all areas: sourcing of processed materials, garment production, distribution, consumption, and disposal. The environmental damage adds to the pollution, waste problems due to overproduction and overconsumption, low garment quality, as well as producing from non-recyclable materials (WRAP, 2012). The fashion system is complicated, due to its big scope, and it is difficult to find one solution for more sustainable ways of producing and consuming.

The effort towards sustainability and new business models in fashion has been in focus over the last decade, however, change is not happening on the holistic level, and impact is not seen on the broader scale. The industry is still prioritizing quantity and profits, increasing the amounts of unwanted, unvalued, and value-lost garments. The average time for wearing a garment is 2.2 years in the UK. 20 to 30% of garments in consumers wardrobes are not actively in use (not worn regularly), commonly due to not fit the owner anymore (WRAP, 2012). The environmental footprint of carbon, water, and waste months would decrease by 20 to 30% (in UK), if the garment active use life would increase by nine months (WRAP, 2017).

The fashion consumption system is changing - It is predicted that recommerce cycles will have an increased economic value, and the importance of resale, rental, repair, and redesign will increase market value from 3,5% (year 2019) to 23% by year 2030 (Ellen MacArthur Foundation, 2021). Impactful system changes through strategies of circularity, researching more sustainable fibres and methods for textile production, elongating use life of garments through repair and resale models, and educating consumers of better consumption habits are main areas where improvements are made (Ertz, et al., 2019). Additionally supporting political actions are taken to support the sustainable products innovation (European Commission, 2022). Even though improvement is made, the study of holistic, systemic change through produced garment specifications, fit, and suitability for resale models and multiple users (intended or suitable for more than one user) garments represents an under-researched area.

Change must be fundamental and affects how the whole system functions – as well as through changing the produced garment.

The focus of the present study is thus to examine how newly produced garments would successfully assimilate within a new sustainable fashion system, considering how to extend use-times for the reuse system, and increase a garment's value to extend its use-time for longer and greater quality reuse systems. This thesis presents research exploring the possibilities and implications of holistic, systemic change towards elongation of garment use-time by evaluating a reuse cycle and analysing a current sustainability strategy in garment utilisation, cyclability, and durability. The thesis design idea translates the reuse and durability needs and values into the garment construction design and methods. Research has proceeded according to a combination of systems thinking and garment technology: the former to understand the system and analyse the prospects and ramifications of changing it, and the latter to comprehend and develop new ways to value the physical garment.

What follows investigates why garments are unwanted and undertake to pinpoint how garments can be endowed with increased value and thus enjoy a longer use life, leading to fewer discarded pieces and less garment waste. In particular, the importance and necessity of garment fit and construction methods are explored as suitable for recommerce cycles and encouraging multiple users to elongate the garment lifespan, increasing the value for different stakeholders, and offering a solution for a less wasteful system. The thesis is discovering the importance of clothing fit to the body and how it is not considered in discussions about sustainability. Below in the research framework is outlined the logic of how the research process brought this project to conclude that the concept of physical garment fit might contribute to sustainable fashion systems.

The thesis explores the opportunity to introduce a mechanism for garments for adjustability on an example of trousers, offering a solution for multi-user garments with a concept of adjustability. Improving the construction methods of the product and rethinking the critical points of the system.

1.1 Chapter overview

Chapter one introduces the thesis topic and outlays the field of fashion and its current issues on garment waste.

Chapter two presents the research process and methodology used in the project's research phase.

Chapter three analyses the fashion system's systemic view from a fast, slow and circular fashion system perspective and presents the stakeholder interviews results and analyses of their role in the system.

Chapter four gives an overview of common sustainability strategies currently used in the fashion industry to decrease garment waste. Reuse and design strategies are presented together with the concepts of circularity and longevity, presenting different consumption models. Finally, the chapter presents the garment disposal reasons importance of fit and summarises the problem space.

Chapter five explores the adjustability fit possibilities and needs on an example of trousers. Trousers construction and fit improvement methods are discussed. Three different solutions for fit improvements are explored more closely, from which one is selected for further testing and development.

Chapter six presents a garment adjustability mechanism concept Uuse and analyses its place and the possible effect on the system. Next, concept benefits to the sustainable fashion industry use and reuse phases are explored. Finally, a discussion with stakeholders evaluates the concept.

Chapter seven discusses the project's future and its limitations, concludes the research results, explores the possibilities for further development and research and presents the study's contribution to the field of sustainable fashion research.

Chapter eight summarises the study and its results.

1.2 Limitations of the study

In a fashion system, everything is interlinked and vital; however, due to the scope of the research, it is essential to bring out that the thesis is not concentrating on the following areas:

Materials: The thesis looks at the garments as a whole and is not separating garments into individual materials. The thesis is not looking at textile or materials precisely because li is looking more at the garment as a whole. Material is essential, as it is a high percentage of the garment; however, as the textile is a vast and separate area, it does not fit into the scope of the research. Additionally, there is an ongoing discussion on

which fibres are more sustainable than others, as many disagree with the current list of preferred fibres (Kassatly & Baumann-Pauly, 2022). There is a lack of recent and detailed data in many fields, including fibres and material research. Also, dyeing and finishing processes often have a more significant impact than fibre production. Therefore, the product is used in this thesis, not individual materials used in garments.

Consumerism: The research is not looking at consumerism. It does not concentrate directly on researching consumers' behaviour or reasoning of consumption habits. Consumers have been perceived mainly as problem owners, told how to shop and what to wear, but this study does not have to look at it from a consumer angle as they are not creating the problem, as they are consuming the clothing, not producing it. However, while not being the main concertation point, the thesis explores solutions that enable consumers to use the products for longer.

Time: The study does not include the history of consumption or fashion; the current state of the industry is taken as the base of the research.

Location: The study is limited to Estonia and London, UK. Looking at two areas, Estonia as the author's location, representing a more traditional and London as an innovative market where sustainability trends and strategies are more developed and explored.

2 METHODOLOGY

This chapter presents the overview of the research, framework, and chosen research methods used in the study.

2.1 Research Overview

The thesis is an open-end design research project. The project's starting point was the subject of sustainable manufacturing and the role of garment manufacturers in the supply chain. The context of how the garment industry is changing due to the increasing consumer knowledge of sustainability indicated the angle; consumer knowledge also raises the confusion about sustainability. Therefore, a systemic manufacturing and product perspective approach was taken for the research. Over time, the topic has evolved by collecting more insights and knowledge through interviews and literature reviews. During understanding the industry efforts on sustainability from different stakeholders' positions, the lack of information and action toward the quality and construction of clothing becomes the angle for the research. The concept of elongating garment use life led the study to concentrate on looking at garment quality and value to the stakeholders and improvements to reduce the waste and wasteful consumption of garments.

Research question
- How can changing garment construction elongate garments' lifespan and increase the potential for reuse?

Goals
- Discover how to change the perceived quality for consumers based on garments adapted to be suitable for reuse and consumption cycles.
- Engineer a garment which will change how garments are manufactured, used, and reused. Achieving the goal to elongate the garment's use life.

Objectives
- Engineer, based on research, a sample of a garment that enables the goal of elongating the garment's use life and analysing how the garment's lifecycle changes in the system.
- Argue that the quality of garment fit would change consumers' perception and value of it.

Hypotheses

- Change in visible garment construction would change the perception and relation of the different stakeholders.
- Good fit increases garments' value and makes finding multiple users for one size garments easier.
- Garments designed and constructed to be suitable for circularity and multi-users (considered longevity, durability, and circularity) have a longer and more valued lifecycle.

2.2 Research Process

The research looks at the garment manufacturing system together with current sustainability strategies, the aspects of quality of the garment, including emotional and physical durability of the garments. The research is conducted based on qualitative research methods, supported by personal professional experience in the industry and a literature review. The research uses systems thinking together with understanding garment construction through garment technology.

2.2.1 Systems thinking

Sustainability in garment manufacturing is a complicated subject that is part of the system and viewed as separate system elements that operate together as a whole. System thinking helps to view an extensive complicated subject as a whole and understand how adjusting and redesigning the elements affect and modify the other parts of the same system (Sterman, 2013). System thinking is to analyse the system and indicate the leverage points (Meadows, 1999). When viewed as a whole, the fashion system contains many stakeholders and different aspects that affect the system functioning holistically. System thinking (Webster, 2017) is used to understand the system and indicate the areas of improvements. The study applies a systemic approach to visualising the system and placing different sustainability strategies into a system context.

The changes and aspects influencing the parts of the system can have a significant impact on the overall system. A produced garment is the central part in the fashion system, having a touchpoint with all stakeholders. The garment is looked at as a central material object in the system, and the research is conducted by following a produced

garment journey. The system analysis and evaluation are conducted from the garments' view and journey points as a central product in the system.

2.2.2 Principal Authors

Because this project intersects the spheres of theoretical and practical research in the fashion field, it primarily draws on literature that also bridges the practical and theoretical aspects of garment sustainability. The four principal authors treated in this study are:

Kirsi Niinimäki –her research aims toward a new, holistic understanding of the sustainable fashion field, covering fashion design, manufacturing systems, fashion business models and consumer consumption habits. In this thesis, her research covers holistic fashion sustainability aspects and relationships.

Kirsi Laitala & Ingun Grimstad Klepp – their research interest lies within sustainable clothing consumption, from clothing use, maintenance, and care to disposal. The studies used in the thesis cover consumer garment disposal reasons and the relationship between garments and consumers.

Kate Goldsworthy – her core research is on designing for sustainability, circular economy, and material innovation. For this thesis, an important concept discussed is the fast and slow circular garment systems.

In addition to these specific authors, analysis more broadly cites industry specific studies, publications, journals, and sources that tend to be impact studies on sustainability with practical applicability in the professional world.

The concept exploration phase is supported by various popular garment technology and garment construction publications to explore the pattern cutting and garment fit aspects.

2.2.3 Interviews - Verbal Data

The thesis uses semi-structured interviews (Flick, 2006), conducted in two phases: experts from the garment industry and professionals from the repair service providers. The target group included three manufacturers, three brands two garment and sustainability specialists and two repair specialists. The fieldwork was conducted

between September 2021 and February 2022. The interviews were conducted in person or with online video-call tools.

Interviews were guided by pre-written questions and topics (appendix 1). The interviews were not recorded to allow the interviewees, connected to brands or companies, to express their thought in a free environment. The author took written notes during the interview to note down the interviewee's thoughts and answers. Straight after the end of the interview, by using the written notes an interview summary was scripted. The interview written overviews were used to analyse the data. The interview outcomes were collected and analysed by using thematic analysis (Creswell, 2003) using an inductive approach to determine additional research themes and direction. To protect the interviewees' identity and their professional opinions which can be representative or not of the companies they are employed by the interviews are presented as anonymous in the research. The interview analyses' main insights are concluded in sections 3.4.

Interviews with professionals in the garment industry were conducted to define how the system is viewed from different perspectives and identify interest points for sustainable garment manufacturing. The aim of selecting stakeholders from various areas was to gasp the differences in working practices and needs in their fields and see the common areas.

The interviews aimed to understand:
- their view on sustainability in fashion and aspects which concern them
- brand and factory relationships
- the working processes of the ways to elongate product use time
- the visibility and connection with produced garments during their lifecycle
- the importance and use of technology
- role of factories in the future of sustainable garment manufacturing

Interviews with repair service professionals were conducted to overview how the garments are perceived during consumption and in what condition the garments are entering the services. To evaluate the conditions and reasons consumers choose to care for their garments. Finally, to indicate the needs of the future garments which are planned to be using the services in multiple use-cycles.

The interviews aimed to:
- indicate the need and lack of garments from the service's construction and fit restraints.
- understands where the possibilities for improvement are, offering improved garments from durability and adjustability sides.

- ask what is the quality of the garment received in the recommerce and value-adding services?

List of Interviewees

Manufacturers:
1. Sustainable manufacturer, online-videocall interview with company owner, duration 60 minutes, Guangzhou, China / London, UK.
2. Traditional made to measure clothing manufacturer, in person interview and factory visit with general manager, duration 90 minutes, Haapsalu, Estonia.
3. Ready-made garments manufacturer, in person interview with sales manager, and factory visit with production manager, duration 130 minutes. Tallinn, Estonia

Brands:
4. Sustainable clothing brand, in person interview with designer/owner, duration 40 minutes, Tallinn, Estonia.
5. Slow fashion clothing brand, in person interview designer/owner, duration 55 minutes, Tallinn, Estonia.

Specialist
6. Sustainable fashion business consultant, in-person interview, duration 60 minutes, London, UK.
7. Tailoring garment technologist, online interview, duration 60 minutes, London, UK.

Repair Specialists:
8. Professional repairer 1 - online-videocall interview, duration 45 minutes, London, UK.
9. Professional repairer 2 - online-videocall interview, duration 50 minutes, London, UK.

2.2.4 Professional autoethnography

The thesis is supported by the author's previous experience and knowledge of the industry while working in the mass production brand. In addition, the author has experience in fashion design, bespoke tailoring, garment technology, and pattern cutting—professional experience working with commercial brands, mass production factories, and individual designers.

The system is mapped out based on the author's previous professional experience in the fashion industry. In addition, the professional experience gained in working with garment construction, pattern, fit and seeing the industry working habits in a mass production brand have been used throughout the thesis, especially in the system analysis and the evaluation of the information gained from the literature review and qualitative interviews.

3 FASHION ECOSYSTEM

This chapter examines the state of the current fashion system and alternative models to make the fashion system more sustainable. In a departure from the traditional fast fashion business model, alternative consumption and production models for apparel promote more sustainable methods which offer alternative systems for garments manufacturing and consumption. Alongside the traditional fast fashion system, two main concepts are essential to analyse in this context. The qualitative interview-based research in the industry presents findings about the current role of manufacturers and brands and their efforts for more sustainable garment manufacturing.

3.1 Fast fashion system

The fashion industry and consumption started to grow together with the industrial revolution, when the industrialisation of garment manufacturing moved from homes to mass production factories, resulting in an increased mass of garments produced. Furthermore, with globalisation and growing labour costs in the global west, locating production in countries where labour cost is significantly lower has aided mass production of cheap garments. As a result, the number of garments manufactured and sold has grown year by year. Production and sales of clothing have doubled between 2000 and 2015; however, duration of utilisation of garments by consumers has reduced by half (Ellen MacArthur Foundation, 2017). Therefore, the fashion industry's vertical business model is working on the take-make-waste system (figure 1). This kind of system is defined by using resources (take), insufficient production methods (make), and wasteful consumption (waste). According to the take-make-waste system, a brand's value is constituted by producing and selling as many products as possible to increase the profit (Gardetti, 2019) without considering the actual use life of the product. Furthermore, the constant need for new stock and styles for retailers urges the constant change in seasons.

Vertical manufacturing and highly reduced lead times allow brands to have new styles in-store as fast as even two weeks (Camargo, et al., 2019); this phenomenon is called ultra-fast fashion (Weinswig, 2017). After the consumer has had a chance to wear a garment, new styles are in store, tempting the consumer to purchase something new.
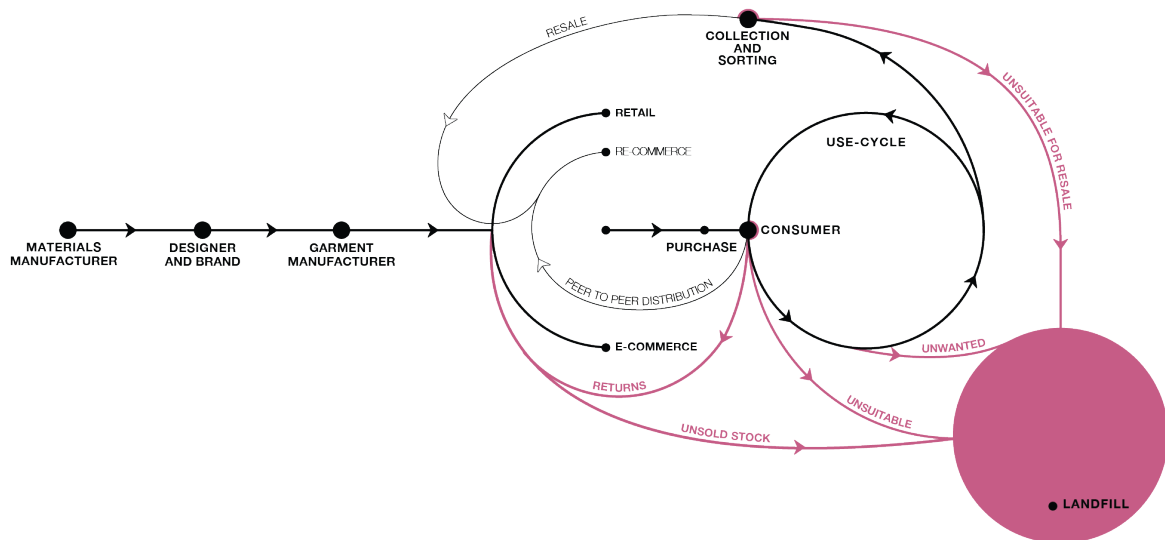
Figure 1 Journey of garments in vertical fashion business model – Tiina Ree

Garment waste issues stem form garment production side- overproduction and prediction-based manufacturing, high minimum order quantity (MOQ), and long lead-times - are causing brands to produce pieces that are not appealing to the customer and not sold. When brands have overstocked the produced garments or unwanted garments and sold them at a reduced price, this creates a misleading notion for consumers regarding the actual price of the products, and thus increases price pressure for brands. The rise of production and sales of garments affected by low prices have created a discount culture, where garments are sold below their actual cost. On the other side, the reduced price creates a decreasing perceived value for garments as perceived by consumers. Garments are used just a few times and then discarded. The value of garments is low for the consumer and given that the discarding of garments after some use-times are not thought through, throwaway culture (Cooper, 2005) is creating a massive amount of consumer garment waste.

The low cost desired by consumers affects production quality by lowering the standards of what is acceptable to consumers. This is because the product will not be worn enough by users to see any physical quality flaws. The outcome is that brands do not receive feedback about low-quality products from customers. 30% of new garments bought are never worn (WRAP, 2012). Because the product price is low and consumer value to the garment does not increase to such a level (due to quick disposal) that would warrant the consumer's dissatisfying user experience, neither consumer feedback nor the actual garments are returned to the brand. Instead, more clothes are bought from the brand.. Overconsumption and impulse consumption create misleading corporate selling data and increase production volumes. The unwanted, value-lost garments are donated to charity, resold, recycled or thrown away. The discarded low-quality garments will find their way to the landfill, directly or from the sorting centres, as they are not sellable or

after a short cycle of reuse. This effect has been seen in the clothing market of Kantamanto Market[1] in Accra, Ghana, where over the last decades second-hand garments have ended up in their market, with a high volume that is not resellable and ends up in landfills. (Dead White Man's Clothes, 2021).

Alongside used or low-quality garment waste, the other issue of overproduction is unsold garments by brands and retailers, which are discarded as they are not sold. The discarded, never worn garments are dumped in deserts in Chile, creating toxic landfills (Duong, 2021). The brands' uncontrollable actions are primarily due to the irregulated system and standards in the fashion industry. Most fast fashion companies are overproducing garments that are not recyclable at a large scale while taking no accountability for the quantities and the quality of the production and has no effort to regulate the waste it is creating. Although different sustainability indexes and methods for measuring product sustainability have developed considering materials, methods, and impacts of products (Gopalakrishnan, et al., 2017), and despite these areas being evaluated, clear meaning of sustainable garments is missing for the consumer as well as the brands and manufacturers.

The fast fashion business model is beneficial for the brand's profits, however, the damage to the environment is caused from the garment waste, both from the production, consumer and used garments sorting centres. The fast fashion system having three important points where a waste is created is a clear sign that there is something wrong in how the system functions. The resources are wasted, and the maximum value of garments is not achieved by not creating quality garments as well as not valuing the garments created.

3.2 Slow fashion

Slow fashion is a concept opposite to the fast fashion business model. While the fast fashion model works on speed and profit, the slow fashion model supports the mentality of slow and mindful consumption, slowing down the production speed, volumes, and consumption (Fletcher, 2010). Slow fashion encourages garments' longevity and timeless design and promotes an emotional connection with the garments. The aspects of slow fashion are making the garments which last longer, more focusing on the social

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[1] Kantamanto Market in Accra is the biggest second-hand market in West Africa

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responsibility and workers' rights and equality, less waste, making the access easier to tailored garments and using more naturally sourced materials.

However slow fashion concept is not challenging the fashion system enough to initiate a change on the systemic level. The change happens in specific brands and consumers who follow the slow mentality. The brands do not have visibility of the usage of their products and the consumers, even if they purchase a longer-lasting and less environmentally damaging ways made garment, it does not guarantee a longer and better use life for the garment. The slowness environmental impact is only if the reduction of consumption is combined with a reduction in production volumes. Buying slower and more durable garments is not viable if the overall consumption is not decreasing. Slow fashion offers an alternative to fast fashion; although, it does not significantly impact the system change.

3.3 Circular Economy

A circular economy (CE) follows a circular scheme built on 3R's3R's: reduce, reuse, and recycle. CE aims to circulate garments more in the system to promote reuse, use resources responsibly and reduce the resources used in manufacturing, distribution, and consumption. Other definitions are introduced alongside the three R's (Kirchherr, et al., 2017), where, similarly, empathise is basing the values on more conscious production and consumption. CE is supporting services to elongate the use-times, caring and valuing for the product and reusing the end-of-life materials for new products through recycling and recovering materials from across the processes on the lifecycle of product (Park, et al., 2010; Yang & Feng, 2008; Stahel, 2016; Kirchherr, et al., 2017). In circular economy conversations, recycling and production from recycled materials have been the loudest topic. However, "*recycling alone is not a one-stop solution to sustainable production and consumption: it represents only a small part of far wider picture*" (Chapman, 2005, p. 15). The circular economy is not based only on recycling, although the attention that is producing recycling has gotten from the industry has linked a strong connection between CE and recycling. Circular economy garment cycles concentrate on elongating garment use life by strategies like reuse, remanufacturing, rent, and recycling (Hvass, 2016).

The fast-fashion brands have used recycled materials in their collection as a vital sustainability element, which has caused misleading information for the consumers. The so-called (the material can have only a tiny percentage of) recycled material to use is

not coming from the fashion industry (used garments) waste, using recycled materials, and still producing too much is not a sustainable act. The low-quality mass-produced garments are discarded with the same speed as the non-recycled material garment. Therefore, not creating a change, just misleading consumers. Criticism of the circular economy firmly states a misleading communication to the consumers, permitting them to consume more and not feel guilty, as the garments are made from recycled materials (Fashionscapes: A Circular Economy, 2021) The change towards sustainability can not be created only by changing the garment's material. A more systemic approach is needed to improve the system.

A circular economy as tackling a wide area of issues, and to fully achieve its goals, it would require all stakeholders to come together and work collectively towards the same goals (Niinimäki, 2018; Ellen MacArthur Foundation, 2021). Based on the interviews in the industry, the values and knowledge about CE are very different; it is still very unclear what the stakeholders should do for the circular improvements. The circularity concept for fashion is not there yet. The improvement and efforts for circularity are made; however, it is too early to expect that the enormous system will change, without all parties to invest in it. Nevertheless, there are many promising projects and concepts following the CE principles, which have created a positive aspect towards circularity, reuse, and improvements and attention to the wastefulness of the fashion industry. But the overall consideration of garment production, especially on the quality and quantity is not fully tackled.

3.4 Interviews with stakeholders

The fieldwork was conducted to study what aspects are important to the different stakeholders in the fashion industry in order to evaluate the efforts for sustainability. Moreover, to indicate an area where an impact for more sustainable industry could be affected. The analysis conducted qualitative research based on nine semi-structured interviews from the industry including manufacturers, brands, and specialists. As was outlined in Chapter 2 (2.2.3), these interviews were conducted according to a specific protocol.

Manufacturers

Three main points come to the foreground from the point of view of manufacturers in the course of interviews:
- Brand sets the quality standard, and manufacturers follow it.

- Factories are missing guidance on sustainability.
- Connection with the product ends when a product has left the factory. The ownership of the product moves to the customer (brand).

Two of the traditional manufacturing representatives interviewed do not have a sustainable strategy. The factory itself does not have the knowledge or capacity to implement sustainable methods for waste management, production volumes or the manufactured garments quality. As manufacturers function as service providers, they do not have the power over the clients (brands), they can influence the design and development processes with their suggestions and knowledge, but the last word and the final decision is for the brand to make. The third interview with sustainable manufacturer representative who is transitioning the traditional manufacturing ways of working into a new sustainable paradigm, by improving sustainability aspects as: workers' welfare and community, materials sourcing, waste management, and green energy. Even if the sustainability on the manufacturing level is improved the area of product quality is not set as one of the sustainability goals, as the brand is making the decision on the product quality and the factory has no power to overrule the brand's choices.

Brands

Two main points come to the foreground from the point of view of brands during interviews:
- Sustainable materials are expensive, and customers (consumers) are price sensitive.
- Sustainability aspects are looked at mainly from the perspective of material composition.

The two brands interviews were both sustainable brands. Moreover, their primary consideration of sustainability came from material aspects: one of the brands focused on material compositions (for example, cotton, hemp, linen, etc.) and the other using dead-stock fabrics. Neither of the brands have a strong strategy of tracking fabrics' quality or testing durability. The consideration of sustainability is guided toward perception aimed at the customer. Customer dissatisfactions focused by the brand are mainly on the fit or sizing of garments. The lack of returns or complaints regarding physical failure gave the brands a notion that their products are of good quality, and they assumed that no-feedback is actually positive feedback (the proverbial 'no news is good news'). The second area of sustainability came from the waste created during production and use of un-sold garments; however, consumer garment waste was not mentioned. From the brand designer's perspective, the connection with garments ended

when the garment was sold, and there was no feedback regarding garments' performance or use-quality.

Specialist

Four main points come to the foreground from the point of view of specialist throughout interviews:

- Brands have too much power over the decisions.
- Designers overdesign garments, too many new style garments every season.
- The industry works on competition rather than collaboration.
- Action from all parties from the supply chain is required for a more sustainable industry.

The specialist interviewed was a garment technologist and sustainability specialist working to advise brands on their sustainability journey. The interviews indicated that the designers have much decision-power in the company. Designers have a strong voice in garment manufacturing and sustainability decisions regarding the design, but in some cases, the designer's knowledge is inefficient on the materials side. As mentioned before, there are still broad discussions on materials and fibres sustainability. The designers are used to bringing in newness to the product ranges. However, improving the best-selling products to allocate longer developing time for the already proven well selling and loved products by customers products is not the priority- continuously designing new styles is prioritized.

From the supply chain aspect, the interviews indicated that manufacturers are expected to offer various solutions to the brands to improve production. Nonetheless depending on the method or improvement for product development and planning, the brands' and designers' technological and process knowledge is often not at the same level. For example, if a manufacturer is offering more sustainable sampling methods (3d-modelling), then as the brand's designers are not educated on the programs used, the offers from the manufacturers can be declined. This results in not adapting to new sustainable improvements used as a brand are not investing in continuously following the industry innovations. The sustainability of the supply chain is viewed from the carbon emission, transparency and wider material offering. However, it is noted that the sustainability throughout the supply chain is not consistent. In the interviews, examples are mentioned where the brand promotes sustainability from the materials composition perspective; the factory where the fabric is woven does not have a plan for sustainable energy consumption. In both interviews, the collaboration aspect is strongly mentioned as missing in the supply chain.

Repair professionals

Five main discussion points come to the front from the point of view of repair professionals throughout interviews:

- Consumers are not aware that products are possible to alter (like trousers waist)
- Users wait too long, usually to the point that a garment is already falling apart, rather than acting on the first signs of damage.
- A possibility to share the data to producers from repair of garments for feedback and future improvements. Repairers have no communication with the brand who manufacturers the garments. Possibility of collaboration between different distributers, service providers and manufacturers/brand to share the information and skills.
- The culture of care is rising. The commercial demand for repair is increasing together with new platforms and raise in people offering repair services.
- People repair more luxury garments and garments with sentimental value or their favourite pieces.

The repair professionals' interviews opened an important topic of garment maintenance, consumer value and attachment to the garments, consumers habits and reasoning for using repair services and the possibility of repair and brands collaboration. The aspect of garment repair is an important aspect on the garment lifecycle, but it is not commonly used by consumers. The repairing process is timely and therefore the skilled repair of a garment can be more expensive than buying new. Even though the high price, the culture of care is rapidly increasing (in London) due to new applications, which make finding a repair professional easier. During the interviews important aspect of the moment when garment is repaired was interesting, as it was noted that often customers do not react to the small damage on the garment, therefore the repair jobs are more difficult. More often are repaired garments which have an emotional or historical value to the consumer, or they are their favourite pieces. The other aspect of repair is the material value of the garment, where a luxury piece is repaired (also then the original price of the garment is much more than the cost of repair). Both interviews indicated a strong possibility to include repair as a normal part of the business model, where brands can take back their product, repair, or maintenance them and then circulate back to sale. In addition, the repairability can be easily designed into the original design of the garment, as adding patches or brands selling repair kits specifically for their product (example using iron-on patched for puffer jackets rips).

Discussion

The analysis showed that sustainability issues were important to most of the parties interviewed. However, topics and concerns from the five different stakeholders varied considerably. Each party approached aspects of sustainability from a different and rather narrow perspective:

- Designers considered sustainability of used materials, design, and methods
- Manufacturers focused on achieving the quality set by the brand
- Garment technologists scrutinized system faults
- Sustainability specialists were concerned with marketable and measurable sustainability indicators for brands
- Repair and maintenance see themselves as a sustainable act, which is increasing the sustainability of garment.

All stakeholders had their take on the sustainability approaches. All interviews showed a lack of consideration about the importance of the consumed garments as a factor for the sustainability approaches, as any participants did not highlight it as the leading sustainability approach. This notion indicates that garment manufacturing and design concentrate more on the other aspects of sustainability rather than looking at the produced product and its role in changing the system to become less wasteful. The interviews indicate that the opportunity to improve the original garment design is not at the centre of the sustainability conversation. The point in improving sustainability can be on the point of garment development. Adjusting the garment construction and design to suit the other sustainability schemes to enable a better and longer garment journey in the lifespan is a missing link in the system-wide sustainability aspect.

3.4.1 Garment visibility for stakeholders

Garments are products which go through the fashion system and have a connection with all stakeholders. However, while they have this connection with the stakeholders, the interviews conducted indicate and this connection is not strong. The transparency of the garments, i.e., where they are coming and where they end up is hidden, and therefore sustainability issues are misleading and confusing for all stakeholders. The lack of transparency has been an essential topic in the sustainability conversation, and as such this issue within fashion industry is improving due to consumers' rising knowledge and pressure added to brands. The annual transparency reports indicate that brands have started to see the importance of transparency, and more information is collected and communicated to consumers and institutions (Fashion Revolution, 2020; Fashion Revolution, 2021). The collaboration in the system is lacking; however, and to have significant, impactful changes in the industry, collaboration needs to be improved.
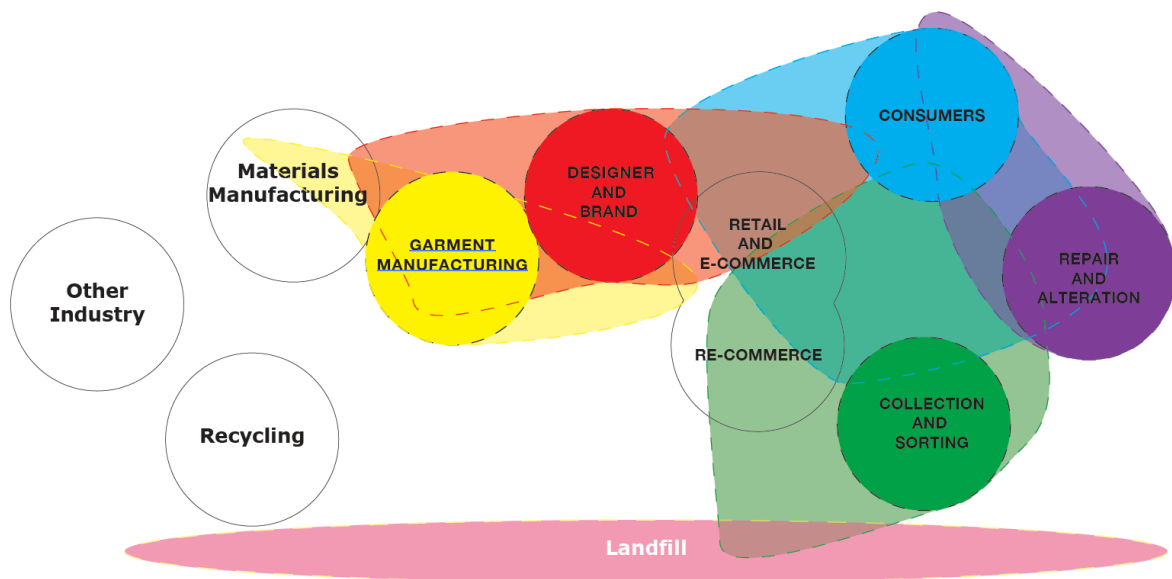
Figure 2 Fashion system visibility map – Tiina Ree

The visibility of the garment in the system is limited for each main stakeholder (garment manufacturer, brand and designer, consumers, retail and distribution, maintenance, and collection and sorting) due to the lack of communication, interest, and initiatives. None of the stakeholders has complete visibility over the system, seeing only a limited part of processes. The system visibility map (figure 2) illustrates the view of the stakeholders' garment lifecycle visibility overlaps. Interviews indicate that the stakeholders connect with a garment when the responsibility and ownership of the garment are theirs. However, passing on the garment in the system, the responsibility and connection are also passed on. After the garment is passed on, the connection with the product is disconnected. Therefore, what happens with the garment in the lifecycle is often perceptible by all stakeholders.

3.4.2 Garment value by stakeholders

There are six main stakeholders in garment manufacturing: garment manufacturer, a brand/designer, retail and distribution, consumers, maintenances services and collection and sorting centres. The connection and roles regarding garment production creation, distribution, consumption, and end of life management differ among stakeholders. The responsibility and meaning of a garment change throughout the garment lifecycle depending on which stakeholders' perspective garment is viewed from. The quality of a product is subjective and can be defined differently depending on the perspective (American Society for Quality, n.d). Understanding the quality of the clothes is different from valuing the clothes. The value of something is very individual and reflects the personal purposes of what is valuable and what is not. Therefore,

stakeholders see the value of garments differently. The gap in perception resolves by variances in defining the quality, and this can be individual based on requirements and interests.

In technical usage, quality can be defined as having characteristics that satisfy specific needs set or a product free from deficiencies (American Society for Quality, n.d). Also defined as fitness for use (Juran, 1999) or conformance to requirements (Crobsy, 1979), which are more traditional definitions of quality, concentrating on the product quality towards the processes it will go through and following the required specifications.

Bubonia (2014) defines garment quality via three different approaches: product, manufacturer, and user-defined quality.

- **Product defined quality** – based on brand quality levels. Design, material, components, assembly, seam construction, finishing.
- **Manufacturer-defined quality** – based on meeting specifications set by the brand. Material components, methods of assembly, construction, finishing and packaging.
- **User-defined quality** – based on consumer appreciation. Cost, purchase price, expectations, value, aesthetic, performance, and function.

To evaluate the quality value to stakeholders, three main stakeholders' value differences are viewed more closely.

- The brand and designer represent product defined quality
- Garment manufacturer to explore manufacturer-defined quality for garments
- Consumers to open user-defined quality.

The role of brand and designer is to set the standard for design and production. In the typical stakeholder relationship, the decision power is on the brand together with the designer. The standards for the design are formed based on the previous sales data, customer feedback, and trends predictions. Standards set for production based on quality feedback, production price, and minimum quality standards (MOQ).

Garment fit for purpose or fit for use is a combination of suitable material and construction methods (Piippoo, et al., 2022). The designers define the minimum standards for different kind of garments based on the intended use and considering the potential dissatisfaction areas of the customer depending on the type of garments. The indication for required quality for products depends on their intended use for the consumer; equally important are the different use requirements for different clothing categories (Gwilt, 2021). The appearance and the 'quality' of a product depend on where the garment would be used, as well as which kind of wear it would be used and what

kind of wear it would go through. The intended use of products is defined in many steps in the manufacturing and consumption cycles. Currently the designer is the one who is setting the suitable and intended use for the garments, being it a function (example rainwear) or occasional based use (basics, eveningwear). However, determining the intended use is determined in the design phase it does not guarantee that the consumer will use the design phase does not guarantee that the consumer will use the garments according to the original use. Additionally, through time and style changes the intended use can be transformed.

The designer and brand quality specifications are communicated for the manufacturer with specifications sheets such as, tech pack, design pack, bill of material, measurements sheets, and testing standards. Brand consumer communicator tool is retail and marketing, which are platforms to communicate relevant information to the consumer about the products and services. Different company quality goals are greatly dependent on their products user feedback, by understanding their quality expectations (Piippoo, et al., 2022), different brands have different quality standards set by their consumers depending on what type of brand it is and what needs of their customers their products are fulfilling. The research also indicates that the responsibility for brand is also an aspect of quality (Piippoo, et al., 2022), CSR, considering environmental, social, and economic impact of their products.

The role of the garment manufacturer is to follow the production standards set by the brands and designers. Product specification and defined quality standards, such as quality assurance, are set by manufacturers to hit the target quality. Quality control procedures for production processes ensure that the standard is kept on all levels across the products. Specific standards are set for manufacturing quality, for example, ISO quality standards. The manufacturer must inform the brand of the issues and problems with the products, and joint decisions are made.

The passed on ownership aspect (where the ownership is on the stakeholder who physically owns the garment) of the production is an area supporting the brands not taking full responsibility for their production, as garments produced are legally a manufacturer's property, as long as it is sent out from the factory. Therefore, the manufacturer's pressured to ensure the satisfy the customer (brand), to avoid the production cancellation or rejections before it leaves the factory.

The pressure on accomplishing set quality lies on the manufacturer. However, leaving the improvement of the product to the responsibility of the brand, not the manufacturer. This is because manufacturers are service providers, and they do not have decision power over what is the produced goods' specifications.

The role of the consumer is to consume, care for, and use the product as well as they are responsible for appropriate disposal reasons and methods. Their role also includes maintaining the condition of goods so that other people can use and wear the products after them. Consumer is a central player in the garment lifecycle. However, the role of consumers is straightforward. The value perception and perceiving are very individual from person to person. Therefore, the same garment can be valued very differently by different consumers. Quality for consumers can be categorised as quality indicators perceived before, during and after use:

- Objective quality, measurable and quantifiable, observed before use. (Price, appearance, material qualities, construction methods, information presented by retailer)
- Subjective quality – based on consumer-specific requirements perceived during use (fit, size, technical suitability, experience, fit for the selected use, appearance, style and suitability, wear, and tear).

Garment care and maintenance is supported by garment maintenance services, which a consumer can use to improve the garment longevity and use time. In addition, the disposal processes supported by the collection and sorting services act as a link between resale, remanufacture and landfill.

The garment quality is perceived different per each stakeholder. The common understanding of improving the quality for sustainability reasons can be misleading. If we look at the responsibilities from the garment life cycle, high pressure and responsibility rely on the consumer. However, the brand is in a typical stakeholder relationship, which holds the most power over the product quality decisions and how the value is set and communicated to the consumer. How the consumer values the garment can be different from the following user, and how to increase the post-use value for the future owners/users. It takes to increase the post-use value recognition for the consumers, to make them understand that if the garment does not fulfil their needs, it can be suitable for the following user.

3.5 Systemic opportunity

Slowness, circularity, and recycling conversations have had a positive push toward new regulation. EU strategy for sustainable and circular textiles (European Commission, 2022) set a directive on creating more sustainable textile and fashion industry, regulating the textile waste transport outside of OECD countries, without a specific aim

to recycle or refurbish the waste in the destination country, which will urge the countries and brands to limit the garment waste. Additionally, the guidelines urge developing and encouraging reuse, increasing the longevity and circularity of products, and extending producer responsibility. Although The base for sustainable development is set, there is no guideline on how the improvements can and should be made. Therefore, a development in sustainable strategies is needed. Alternate models such as slow fashion and circular economy have given an alternative view, challenging the fast fashion business model. There are progresses, but systemic change is not happening.

Together with the designers, the brand has the power in typical stakeholder relationships. They are the part which decides what and how is produced. The brand view is taken further to study the garment-specific sustainable strategies and how they can be taken further to understand why the change is not happening even though innovation and improvements are made.

4 SUSTAINABLE STRATEGIES

In recent years, especially after the Covid-19 pandemic, people's consumption and value habits have changed, and more thought is given to unused products afterlife (WRAP, 2020). Increased awareness of wastefulness and damage to the environment from the fashion industry as well as raise of initiatives for implementing sustainable solutions, such as the circular economy and slow fashion, have propelled innovation in the fashion industry. As a result, new business models and strategies that implement ways to reduce the number of garments wasted have surged. Increased sustainability in the fashion system can be tackled from different angles and points: enhancing the materials use, extending the longevity of garments, influencing consumption patterns, and finding new distribution methods. In addition, strategies that impact garment life by extending the product life periods, increasing garments' cyclability, slowing down wasteful consumption and reducing waste creation are looked to explore sustainability.

To analyse sustainable strategies of garments, there are two strategies to be considered. On one hand the reusage of products which are already made. On the other hand, designing new and refined products. This will tackle two different aspects of overproduction. Firstly, garment waste will be reduced through better initial designs and secondly, finding new ways to redistribute and use garments already in circulation. New product-service combinations play an essential role in achieving resource-extensive consumption models (Bras-Klapwijk & Knot, 2001). The aspects of methods and services are looked at in the strategies.

4.1 Reuse

The fast-fashion system has continuously overproduced garments with low value, which are never sold, never used, or not used enough, or quickly turn unusable. Reuse models are becoming increasingly popular, supporting the idea of multiple users for one product, and giving a new life to already used products. Together with the use-again models, new distribution models are commercialised, supporting the idea of having shorter but more use times for one product. Product, together with the additional services are introducing new business, and distribution models as well as maintenance services to support the product endurance.

A product-service system (PSS) divides services into three subgroups (Tukker & Tischner, 2006):

1. **Product-orientated services** – Services that add value to the product include maintenance, redesign, take-back, consultancy, and customisation.
2. **Use-orientated services** – Services where the company owns and maintains the product, such as renting, lending/leasing, pooling (clothing libraries) and swapping.
3. **Results-oriented services** – focusing on the service offered to customers as the highest result. (Not applicable for garments)

Product-service system creates a new value proposition, focusing on creating new consumption models (Niinimäki, 2018, p. 20). PSS enables multi-use of products by offering services to alternate use of garments to ensure the value is sustained for the garment. PSS proposes a solution for increased durability, elongating the garment lifespan, offering additional or replacing the revenue streams, and supporting new business models to decrease the need for new products manufactured to decrease the number of garments (Armstrong, 2018, p. 103). The PSS solutions offer a garment the possibility to have an extended use life.

PSS categorises the services and creates an alternative way to redistribute and consume the products. The PSS categorisation is relevant, yet there could be a better way of categorising. Therefore, the author has grouped a new garments' categorisation for supporting services and methods for garments reuse. PSS categorisation (Tukker & Tischner, 2006) is not the best way to categorise garment reuse. Firstly, the result-orientated services are not relevant for garments. Secondly, the product orientated services group different services which aim, and processes are very different for garments. As an example, services such as redesign are in the same categorisation as consultancy, in spite of, redesign is changing the characteristics of the original product and consultation offers a service where advice is given (for example styling, combining) without changing the original design or characteristics of the product. Therefore, the following categorisations are developed for separating different services and models, elongating the use of already existing garments:

1. **Redistribution services and methods** – passing the product onto the next owner or user without changing the product (commercial and peer to peer distribution such as resale, renting, sharing, borrowing, and others).
2. **Value-adding services and methods** – improving and maintaining the product without changing the main characteristics of products (care, repair, consultancy).
3. **Remanufacture services and methods** – changing the garment's main characteristics (alteration, remanufacture, redesign).

4.1.1 Redistribution services and methods

Redistribution is a process where the product (in a usable state) is given to the next use by the distributor (Goldsworthy , 2014). The distribution of garments can be done by the distributor or directly peer-to-peer, with or without tools or services to support the distribution process. Redistribution gives garments the possibility to reach new users, lengthening the garment's lifespan and extending the possible use time of the garment. It is suggested that the first user's active use of the garment is typically higher than preowned garments' use. Therefore, improving the first users garment use-experience should be focused on more (Laitala & Klepp, 2020; Laitala & Klepp, 2021).

Nonetheless, agreeing with the importance of the first user-relationship with the garment, the study does not present the reasons for decreased use time for preowned garments. Therefore, the data is not entirely beneficial for understanding how to elongate the reused garments' use times. In spite of knowing the reasons, the study still states the favourable elongation of garments when redistributed to the new user even if the original use-time is longer.

Redistribution methods typically requires supporting additional services for collecting and sorting the garment before it is redistributed. The distribution methods vary in how they function and with whom the different parties are involved.

Collaborative consumption is an area of developing business models and services that allows a garment to have a multi-user lifecycle. The concept of collaborative consumption includes redistribution services and models which features enable products to be distributed to a new user by renting, sharing, swapping, borrowing, giving, and gifting. Collaborative consumption service replaces the single user of products aiming to influence the consumers to move from ownership to shared use of the product (Piscicelli, et al., 2015). Collaboratively consuming garments would lead to higher use-intensity of the garment (Bras-Klapwijk & Knot, 2001), as a garment which is used by multiple users' garment use time would increase, example, through renting service, where the time when the garment is not in active use can be rented out to another user. In a more extreme example, the seasonal garments could be distributed between different climate areas example, one winter coat could be used for one winter in northern Europe, and for the north summertime, it will be sent to Australia where it would be used for the second half of the year as the weather would be cold there. Therefore, garment utilisation would increase by employing many users to use the same garments. Collaborative consumption divides into commercial and peer-to-peer redistribution (Henninger, et al., 2019).

Commercial redistribution is directing garments to the next use through commercial enterprises. Business-led redistribution usually has three steps: collection, sorting, and distribution.

- **Collection** – organised points for consumers to return their unwanted garments (take back schemes, charity collection, recycle points, garment collection points, resale collection points).

- **Sorting** - The sorting in the collection points depend on the size and the structure of the organisation. In the sorting process, the garments are divided based on the quality, value, and suitability (markets, regions, style), from where they are moved to the redistribution channels.

- **Distribution** – Distributes the garment based on the sorter quality evaluation. High-value clothes are distributed to resale (second-hand stores, commercial resale, resale markets). Lower value garments are distributed to remanufacturing and sold by the kilogram to resale. Unusable and value lost garments are sent to recycling centres or are discarded in landfills.

Peer-to-peer redistribution is passing garments from consumer to consumer without a commercial enterprise to organise the collection, sorting, and distribution. The sharing between consumers uses different tools to communicate and organise the transaction. However, different platforms, sharing platforms, marketplaces, apps, or events can be used to organise swapping, lending, borrowing, renting, sharing, giving, and gifting.

The collaborative consumption increases the potential for reusing the garments, however the issue on redistributed garments appeal to the new consumers, still affects the longevity and redistribution possibilities. In the multi-use garments are many issues, why the models are not working on a broader scale in the industry. By increasing the number of users and duration of use, the garment quality must be loked over to ensure the physical quality of materials and the multi-user needs are designed into the garments (Henninger, et al., 2019).

4.1.2 Value-adding services and methods

Value-adding services refer to methods of services that increase the value of the garment and elongate the active use for the owner. In this context, the garment's value refers to the garment's emotional, social, and material value. The value-adding services and methods retain and add value to the garment by adding extra effort and attention. Tactics for elongating the use life and emotional or physical value of garment are care, repair, and consultancy.

Care - The garment care activities (Bras-Klapwijk & Knot, 2001); the users usually perform regular care of wash, wear, drying, ironing, and storing. However, specific garments also require special cleaning or drying processes. Care practises also done by a commercial service provider, depending on the garment care requirements and household culture. Many countries do not have household washing facilities; hence the use of laundrettes and dry-cleaning services are part of the garment care process as a personal effort, and care has been put into the maintenance of the condition of the garments.

Taking care and maintaining the garments increases the connection with the garments. Therefore, a consumer may keep garments with higher emotional value longer. However, this does not indicate that garments are actively used more (Niinimäki & Armstrong, 2013). The aspect of emotional or a personal attachment for the owner does not mean the garment will be used more. On the contrary, the garment might be used less to avoid damaging it, as the value for the owner is higher; therefore, the responsibility and carefulness for the garment are also higher. In addition, peer-to-peer-based activities, and community initiatives, mending and knitting clubs, workshops, and events increase the emotional effect of participating in caring for the product. (Hirscher, et al., 2018).

A more precise and considered care of garments will be applied with a higher value garment. For example, more consideration and carefulness in choosing the washing methods, paying more attention and protection when worn, and finding ways to maintain the garment's accidental wear and tear damages can be applied to the garment with high value. Durability is a customer's responsibility. The durability of clothing depends not only on the materials and value but also on the care methods, consumer knowledge and brands communicated care methods and suggestions (on care label or website).

Repair or mend is a value-adding action that elongates garments' physical durability by offering a service such as fixing and mending the breaks and weakened areas in the garments. It is an alternative route towards sustainability which focuses on maintaining clothes by repairing or reinforcing the damaged areas of the garment to elongate the use time. Domestic garment repair has historically been used in households, as the material and financial value were higher, and maintenance was more part of the regular care practises applied to the clothes. With the decrease in the price, the repair is not commonly used anymore. Many people have lost the skillset or have never been taught the skillset of stitching or craftwork, which they could use to care for their garments. While the individual care of clothing is not always a standard, hence, service providers are essential in repairing the garments. However, with the issue of repairing the

garments, the repair services can be expensive compared to fast fashion clothing low selling prices. Buying a new piece can often be cheaper than using a repair service.

The repair can be applied as invisible or visible, depending on the preferences. Invisible mending follows the garment and textile's original design, which will be matched as close as possible during the repair process. Visible mending is a form of art where a contrasting and visible repair method is applied. The visible mending has been considered to give an extra value to the garment by an individualisation (for example, adding a patch or embroidered symbol over the hole) or deepening the emotional connection with the garment. The emotional connection of garments and sentimental value is one of the ways to elongate emotional durability.

Durrani et al., (2021) recognise the importance of the material study of worn-out garments as educational opportunities for designers to learn from breakages and repair for the design process. In addition, repair, breakage, and damages of the garments could be valuable information for the brands, designers, and manufacturers to gain knowledge and feedback on the garment's condition changes during the use.

Consultancy is a service of advising the user on selecting, combining, or styling the garments to gain a more pleasant visual appeal for the garments worn. Personal styling and wardrobe consultations are often not available for the regular consumer due to the high price of the service. Consumers by using styling and consulting services can learn how to restyle clothes from their wardrobe. Consultancy relates to the rediscovery of clothes, continuing a use of a garment which has not been in use. The garment is rediscovered and gained a different view from the owner. Rediscovery can be an essential aspect of elongating an active use time of clothing in people's wardrobes which have not been actively in use.

4.1.3 Remanufacture services and methods

Remanufacture is a design approach/process of redesigning, refurbishing, or updating the garment into a garment which value is higher than the original version – also called upcycling (Goldsworthy , 2014). Sinha, et al., (2016) describes remanufactured fashion as using the old unwanted clothes into a new, without lowering or even improving the original quality specifications and keeping the original producer labels. Remanufacturing changes the garment's original characteristics, including the design or functionality (as it can become a new type of product). Remanufacturing is a more complicated process than traditional manufacturing due to the variability in quality and quantity of materials available (Sinha, et al., 2016). Even though the complexity the minimisation of new

materials gives the resource and energy-saving aspect. Remanufacturing follows the cradle-to-cradle (Braungart & McDonought, 2009) approach, in which materials are not in active use and are used for new products without lowering the value of the material yet using it in lower value products called downcycling.

Remanufacturing requires a substantial and individual impact on the garment's design (Sinha, et al., 2016), as the material characteristics and usable size vary from garment to garment. The difficulties of increasing the market size for remanufacturing require a change in the system, where the used garment is valued as a possible new material together with the infrastructure of collection, sorting and evaluating the usability of used-garments materials. The use of already manufactured garments as a new material would help to increase the number of garments in use cycles and decrease the discarded garments due to lost value for the consumer. The change in consumption cycles, value seen in garments and system infrastructure improvements are needed to organise the structures for successful and wide-scale remanufacturing of garments. There is a possibility of remanufacturing to improve the unwanted and discarded garments by appearance, fit, sizing, and function.

Redesign is where discarded garments are used as a virgin material for the new design. Redesign is also called up-cycling. The upcycling of used clothing is currently on a high rise due to the high quantity of discarded and unsellable garments is making the used garment upcycling cheaper to produce than buying a newly produced fabric.

Alteration is the process of altering the garment's fit, details, or size. The ability to alter the clothes is limited. For example, classical tailoring leaves 1.5 to 3 centimetres seam allowance on seams left for alteration. The cost-saving need for the garment has removed the additional allowance, and the benefit of possibly altering and letting out seams is lost. For making garments smaller can be difficult, as with the automated machines and seams innovation, many seam constructions do not allow for extra material on the seam, as well as unpicking the seams can be a very time extensive job. The need and active use of alteration services have declined as the garments are not owned so long that alterations are needed, as well as since the alteration can be more expensive than buying a new garment.

4.2 Design strategies for new production

The design strategies for delaying garments' disposal through design are more of the root-cause solution for the garment waste problem. Design strategies for the new

products are looked at from strategies where the sustainability aspect is designed into the product. The garment elements and design choices are based on the use life predictions for the garment. Ellen MacArthur Foundation (2013) suggests two opposite ways to keep product materials and components in use longer in the CE system: increasing the use-time in one cycle or going through more cycles.

Changes in the garment use phase can influence and induce changes in the production and distribution phase and methods (Bras-Klapwijk & Knot, 2001), and the way garments are consumed can affect the required functions of the garments. For example, when people want to decide to wash clothes differently, maybe more spot cleaning clothing would be developed. Same as if the garments are changing from mono-use to multi-use, then the garment's attributes would need to change according to the users' needs. From one side to accommodate the needs and influence the consumption behaviour and shift the view of the value of the clothing. On the other hand, if the clothing is designed for multi-use and states to have a life after the owner, maybe the consumer would consider it during their consumption cycles.

4.2.1 Design for cyclability

Design for cyclability promotes the strategy of increasing the use-time of garments by going through more cycles. Design strategies for cyclability include a mono-cycle approach and design for disassembly (circular.fashion, 2018). Design for cyclability means that designers must adopt a circular life thinking to the products they design (i.e., fabric selection and design, treatment processes, product use and reuse cycles and care practices, disassembly, and recycling). Understand the processes that occur at a product's end-of-life phases to ensure it can be fully recycled. Design for cyclability is related to the design of closed-loop material systems, viewing material and product recovery, which incorporates the possible life-cycle scenarios led by design (Goldsworthy , 2014).

Speeding up the cycles and empathising on the refurbishment of garments or elongating the longevity by increasing the garment durability and personal connection with the garment. The design methods for the circular methods are investigated in Earley and Goldsworthy's paper (2015), where they explore the multiple and extended product cycles and emphasise how different are the short-life and long-life garments design and material approaches based on the garments' speeds and needs' (Earley & Goldsworthy, 2015). The circular speeds is a concept (Goldsworthy, et al., 2018) which analyses the circular speeds 'super-slow' and 'fast-forward' approaches on design for cyclability in circular fashion multiple lifecycle futures. Understanding the reuse garment cycles is an

important area for designing for cyclability. However, as the designer does not have the total capacity to predict the possible use and reuse of the garment, both fast and slow cyclability design could be applied to one garment. Goldsworthy, et al. (2018) argue that the speed of each garment should not be the same speed to have 'the right speed' of specific use cycles together with analysing the product's lifecycle. The product cycle speed can highly depend on the consumer consumption habits. The design is intended to have slow cycles (more use, fewer different users) or fast cycle (less use by one user and more users). It is challenging to predict the actual cycle speed at the beginning of the design process. Even though not knowing the garment's exact end cycle, the cyclability is essential to corporate in the garment design.

4.2.2 Design for longevity

Design for longevity includes strengthening stress points, aesthetic durability, modularity, transformability, repairability, adjustable sizing, emotional durability, and participatory design (circular.fashion, 2018).

Goldsworthy (2014) argues that the garment material value decreases during the consumption cycles unless the material goes through a process of 'recovery' which retakes the material to its original (raw material) quality. However, technically accurate, the aspect of material value is here only talked from the physical property's aspects and the recovery by additional stakeholder's 'rescue' (like repair or similar). It is not considered the varying value level during one consumption cycle, as the value for one owner or user can also change in time due to different (peer opinions, trends or similar) external psychological influences.

Currently, some products are designed to be more durable than required for their actual life. In the throwaway society, products are discarded before the product's physical material durability aspect (Chapman, 2005). The products that have reached the end of use by one user could be passed on to another user, who can reuse the object. However, this requires changing consumers' consumption and disposal habits and knowledge change. The increase in durability is not affecting the utility of longer-life products. The psycho-social natures of user behaviour and consumption patterns are changed with the product's materials, design, and construction (Fletcher, 2012). Elongating the product use life through product material durability has been proven inefficient due to not considering the physical and emotional durability (Chapman, 2005). The value of the product for the user is a combination of emotional (desire, love, and attachment) and physical (materials) durability (Chapman, 2005). Therefore, both technical and

psychological solutions should be considered by elongating the product use time. Wardrobes with longer-lasting products do not necessarily decrease the environmental impact. The more durable garment can end up the same way in landfills as the less durable garment if the consumer consumption habits do not change with the more durable products.

Design strategies for longevity are looking at various methods and combinations to extend the lifespan of the garments, one of the method is modularity of garments. Gwilt & Pal describe achieving a design as a longevity approach by "*combination of the design-led approaches that helps extend the lifetime of a garment.*" (Gwilt & Pal, 2017, p. 151); authors categorise the aspects as modular garment design and incremental garment design. Modular garment design replaces repair and adaption by a modular attachment system: detachable and removable or changeable details or panels of garment. Incremental garment design is where a design element is incrementally updated by which the garment life is extended by updating the garment's proposition, colour, print, or other appearance elements during their lifetime., colour, print or other appearance elements of the garments during their lifetime.

Cooper (2005) argues that the importance of durability plays a role in the long-life cycle, which contributes to product sustainability. Product life extension through improved maintenance and thorough repair, use, upgrading and reuse (Cooper, 2005). Durability is looked at as one of the main ideas for design for sustainability (Fletcher, 2012). "*For a garment will last only as long as its least durable component*" (Fletcher, 2012, p. 226). Garment durability is an equal effort for longevity both from the consumer and designer. "*All garment journeys are not the same and all users are not uniform in their behaviour and wardrobe curation*" (Goldsworthy, et al., 2018, p. 46). To understand the requirement to design for longevity, the consumption models and consumer disposal behaviour and reasons would need to be considered while making the design decisions towards longevity.

4.3 Consumption cycle models

Different sustainable strategies support diverse clothing use models and methods. Business models such as collaborative consumption and resale, together with the cyclability and longevity, support three garment types with different consumption models: single-user garments, occasional multiuser garments and multiuser seasonal or periodic garments (figure 3).
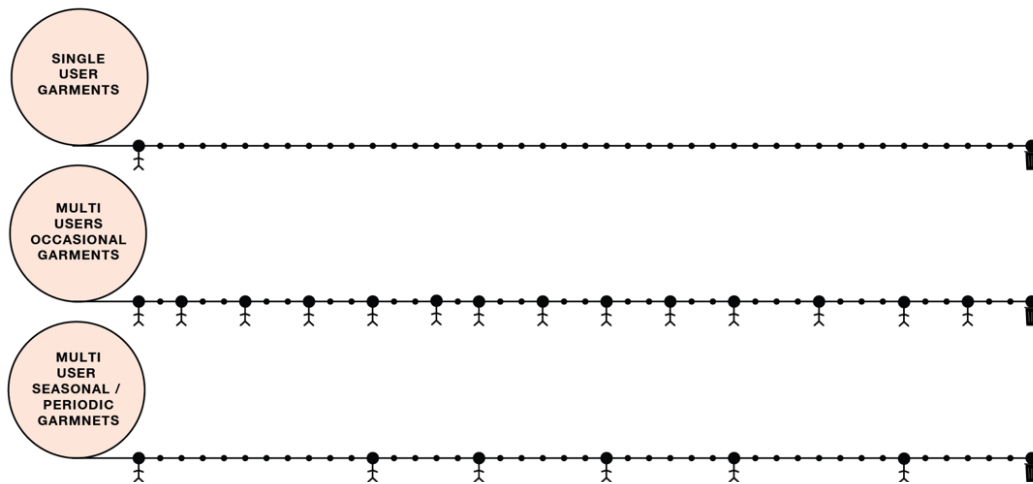
Figure 3 Garments consumption cycles– Tiina Ree

Single user garments are built on garment longevity, where one user will continuously use the product until the end of the useful life. The single user consumption model supports garments with physical durability, extended use life and timeless design. The garments in this model are intimate clothes, essential everyday wear, and favourite garments loved and used repeatedly.

Multiuser occasional garments have multiple continuously changing users for one product. The consumption model is seen in rental, continuous resale, and swapping - a model where one garment is worn a few times by each user and then distributed to the following user (by a service provider from peer-to-peer). Multiuser occasional garments can be functional wear, occasional wear, and fashion statement items, which are not suitable for everyday wear and are usually worn only for special events or functions (skiwear).

Multiuser seasonal or periodic garments build on the seasonality of trends and change on users' styles or needs. The multiuser seasonal consumption model supports the seasonality of garments by its design or function, where a garment is used continuously for a specific amount of time and then redistributed to the following user.

Implementing different consumption models to garments is elongating the active lifespan of the garments by improving the longevity for one user or having multiple users for one product. The singular or multiple users garments are promoting the longevity and circularity, still need for the disposal reasons of garments should be considered. As well as consider the reasons why garments are used more often or longer by consumers, he single-user garments would need to be suitable for specific users for a long time. The multiuser garments would need to be designed considering the possible multiple users, who can have different criteria for quality and suitable garments. As the users per garment can increase, the moments of discarding the garments increase also,

which makes the importance of garment disposal the central aspect and it should be looked at when implementing a multiuser garments consumption as a sustainability strategy.

4.4 Disposal of garments

Disposal reasons of garments is an essential part of the sustainability conversation to understand which garments have a more substantial value and can fulfil better consumer expectations, therefore also having a longer lifespan, both in single user and multiuser consumption models.

Garment disposal reasons relate to unsuitable fit or size of the clothing, poor technical quality, and reasons connected to taste and appearance of the clothing (Laitala & Klepp, 2011). Klepp (2001) cited in Laitala & Klepp (2011) categorises the reasons of disposal into 6 categories:
1. Technical – worn out, ruined, uncomfortable
2. Psychological – Tired of product, out of style, outdated
3. Situational – do not have those needs anymore, changed body size, has similar clothes, lack closet space, do not have use for the products,
4. Never worn -unsuitable for the purpose, impulse buys
5. Functional – New and better products in the market
6. Sentimental – Do not use it because of fear of damaging it.

Research shows different percentages of disposal connected to the reason, which vary between studies and the study target group. Klepp, et al. (2022) have put together a summary of 17 different consumer studies which look at the disposal reasons for garments. Garment disposal statistics from the study are visualised in figure 4. The first aspect of perceived value disposal reasons are cases where a consumer does not want the garment as they find the garment outdated, out of style, the garment is not needed by the user anymore, or the garment value is decreased for the consumer, making the garment unvalued and disposable. The second aspect of disposal is intrinsic quality, where a garment has a technical failure, such as wear and tear issues, shrinkage, holes, colour fade, or loss of technical functions. The third area categorised is a poor fit, where the garment does not fit the consumer body due to the changes in the body during the garment lifespan, or the garment has never fit due to the inaccurate size and fit. Perceived value is connected with emotional garment durability, intrinsic quality is linked to physical durability, and garment fit is interconnected.
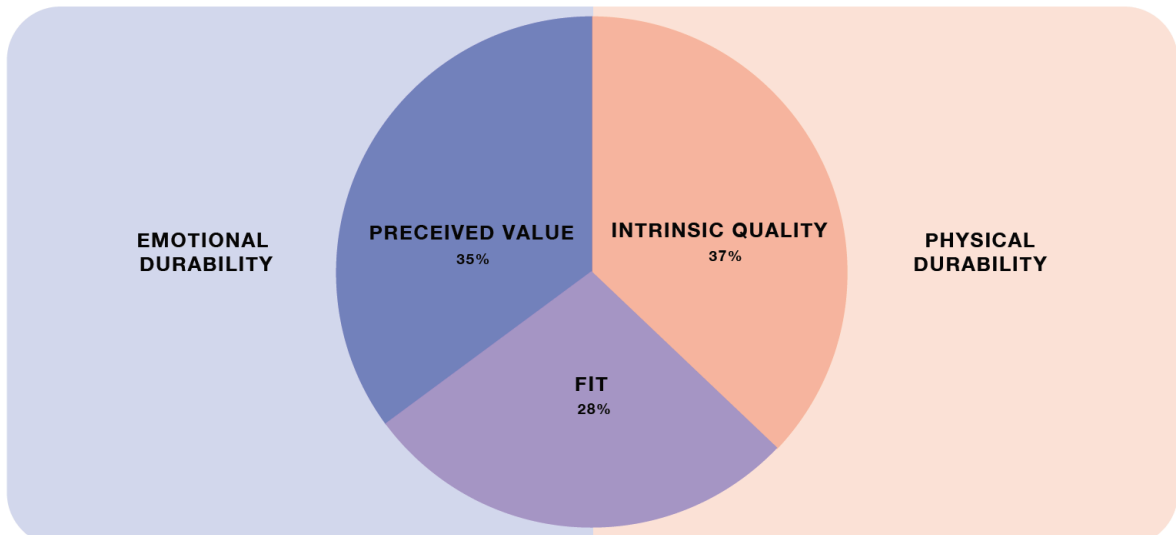
Figure 4 Statistics of garment disposal – (Klepp, et al., 2022)

The physical quality of the product has high importance on the materials used in creating the product. Current systems are based on fast and often replacement of products, and this also affects how products are designed- they are not designed for long time use (Niinimäki, 2011). Design decisions should be based on lab tests of products' technical performance and quality properties in wear (Piippoo, et al., 2022). Required testing standards and requirements for specific products should consider testing the possible use-case of the product. The use of the product can be tested with a wearer trial, where a produced test sample is given to a potential user to simulate the wear and tear and potential situations that might happen during the use of the product. However, the testing is limited by time restrictions for the development process, and the objectivity is not possible to observe remotely.

The disposal of garments due to lack of perceived value is a natural part of the product life cycle. Change in styles and personal values is a natural part of the fashion system and people's style development; therefore, the disposal reasons due to value is an aspect which is hard to eliminate. However, a viable support system should be in place to support redistributing the product to the next user.

Garment fit is connected to value and quality. The value of the garment's appearance on the body is also connected to how it fits and how the user feels wearing the garment, as well as the quality aspects as ill-fitting and tight garments have more tension in certain areas on the body, causing rips and abrasion which can lead to quality failure. The garment fit is an area which is currently not explicitly concentrated on sustainability conversations.

4.5 The importance of fit

Valued clothing attributes, such as comfort, are critical for the garment's appearance (Gwilt, 2021). The garment fit issue is a considerable aspect of the garment's customer value and is more critical on resale models where many users use a garment within its lifespan:

1. The garments have the fit issue waken on the point of purchase. If the garment is not suitable for the consumer's body type or size, the purchase becomes discarded. Therefore, the garment's longevity is, at this point, not relevant anymore as the garment fit issue has already ended the user experience.
2. When a consumer's body type changes during the use-time, the garment can become unsuitable due to the fit.

The garment in resale and rental models where a garment has more than one user, the issues of different body types limit the resale of garments, where the above two fit failure points are for each consumer making the importance of multiuser garment fit a vital aspect.

Different methods such as 3D body scanning and made to measure clothing are used for constructing better fitting garments. The customisation and personalisation methodologies for garment cut are beneficial for single user garments. However, for the multiuser garment and supporting the reuse garment, the issue of single body type fitting remains.

In Gwilt's (2021) research, the most frequently worn garment was a pair of trousers or jeans, especially if they fit well with the wearer. Consumers do value comfort and fit in the garments. At the same time, it is not easy to find well-fitting garments, especially trousers. Improving the fit can be a strategy to increase the usage of clothing that will reach its maximum use. Adjustable fit is one strategy for longevity. Although, the adjustability importance is not seen as necessary in combination with sustainability aspects for elongating the garment lifespan and improving the potential for reuse. Although the importance is obvious, it is not a common sustainable strategy for improving longevity, reuse, and multi-user consumption.

4.6 Problem space

Current sustainable design is looking at a fix of the symptom of the problem rather than solving the root cause of the problem (Chapman, 2005). The sustainable strategies put

great effort into the reuse to find alternative uses for already produced garments. Even though the strategies to design sustainable garments are there, the effort and attention are not in place. The industry is producing similar products with the same disposal issues; even if they are made better, more durable, and more considering the end cycle of the garment, the garments are not designed to fit the changing business and consumption models. Of course, longevity and circularity are necessary, but the solutions are not full without considering disposal reasons, especially fit. In order to have a true sustainable garment the garment should be designed to fit the consumption models, business models as well as take account the consumer disposal reasons.

Ill-fitting garments are a critical aspect of the disposal reasons, but the issue does not have enough attention in the sustainability strategies. The better-designed garments can be quickly disposed of without a good fit, similarly to the non-sustainable garments. With this in mind, whichever sustainable strategy is used for the design (value increasing, distribution or end of life), the true sustainability of the garment is not there if it does not fit the wearer's body. With this in mind, garments require a design based on diverse business and consumption models and an understanding of users' fit issues and requirements.

This study takes the lack of fit consideration as a sustainability strategy further and looks into the aspect of how a garment should be constructed to be suitable for many different users and suit for various business and consumption models.

5 CONCEPT EXPLORATION

Based on the research, an opportunity to improve the longevity of garments could be in allowing a garment to be suitable for more than one consumer. Based on the issues regarding fit, adjustability is taken further as a key area of exploration in the process of developing a concept. Trousers were chosen as an example for the development process to improve garment fit through garment technology.

Trousers are complicated to make fit for individuals due to the shape form and three-dimensional shapes. The garment is also required to have excellent movement capacity to allow for maximum movement of the legs - in addition to positions and postures of sitting, standing, and bending - as each person's body shape is individual. Trousers generally fit close to the body, especially on the trousers' waist and upper area, which is supporting the stability of trousers. Therefore, the superior fit of trousers is more critical and challenging to achieve than other garments that do not have so many requirements for movement and fit. In this chapter, the trousers' construction and fit requirements are further studied to indicate an appropriate concept for better fit.
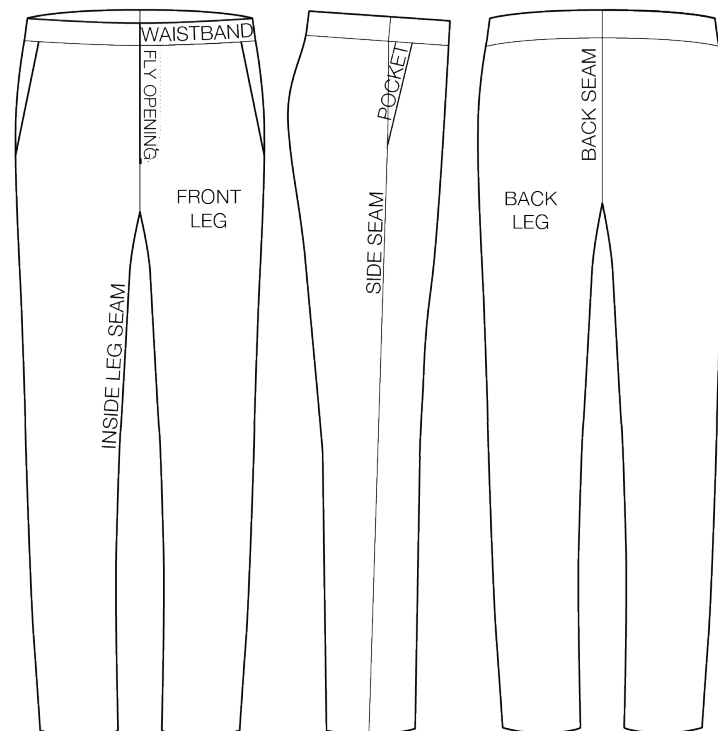
5.1 Anatomy of trousers

Figure 5 Parts of trousers – Tiina Ree

Trousers are traditionally constructed from four main panels (left and right front and back leg panels), with additional panels to support the structure and additional parts such as waistband, fly, and pockets. Figure 5 demonstrates the trousers common parts and seams and their placements. The trousers selected for the concept exploration are a classical tapered leg trousers with two slanted front pockets, fly opening and a waistband.

Sizing of trousers

Trousers are differentiated for different size bodies by waist sizes and are typically based on body waist circumference. EN 13402 (Standard, 2017) is the European standard for clothing sizing, whereby only three body dimensions are used for trousers to indicate the trouser size. However, more measurements are needed to construct well-fitted trousers to accommodate the fit to the consumer body shape. Tailors who construct trousers by individual measurements also require more measurements to detect a customer's specific body type, as well as often it is beneficial to visually observe the body shape and proportions to make calculated decisions on pattern making.

Additionally for the lack of measurements for constructing the pattern brands use models for garments fitting sessions to analyse the fit on the body. However even though the garments are fitted on the body the manufacturing standard allow a slight variation on the sizing as a tolerance on garment final production measurements. Therefor the size and fit of the trousers can vary in one brand, style, and size. The differences between brands additionally vary, as each brand has their own specific sizing. This issue is very visible on reuse garment stores, where many brands are sold together, even though the size on the trousers label are the same, the fit of them can be completely different. The size differences are making finding trouser with a good fit from second-hand stores especially challenging experience.

The sizing of trousers is based on trousers pattern grading from the base size. Many methods (Lim & Cassidy, 2017) and styles are established to specific pattern cutting methods. In addition to the body measurements, the trousers' size is calculated with ease over the body for extra comfort. The trousers' comfort ease is a brand design and fit choice based on consumer feedback and preferences. Garment fit is affected by the system used for base blocks, grading practises, decisions on ease on the body, and pattern construction and cut (Glitsch, 2020). As the anthropometrical data is used for grading and constructing garments, together with the brand chosen sizing (which can also vary from product to product), the product fit is designed for a limited and specific part of the population (Glitsch, 2020). The standardisation of sizes and basing garments on average body type causes circulating garments that do not fit a large amount of the

population. Confirming the proportions and shapes of the bodies, no wonder there are many issues in finding good fit clothes.

Fit issues on trousers

The common fit issues on trousers were studied based on standard pattern cutting and fit issues literature (Alto & Palmer, 2003; Dunham, 2021; Aldrich, 2008; Smith, 1979) which categorised ordinary trousers fit issues. The visual presentation of the common fit flaws is presented in appendix 2. The suggested pattern alteration improvement of specific flaws in fit is demonstrated in figure 6.
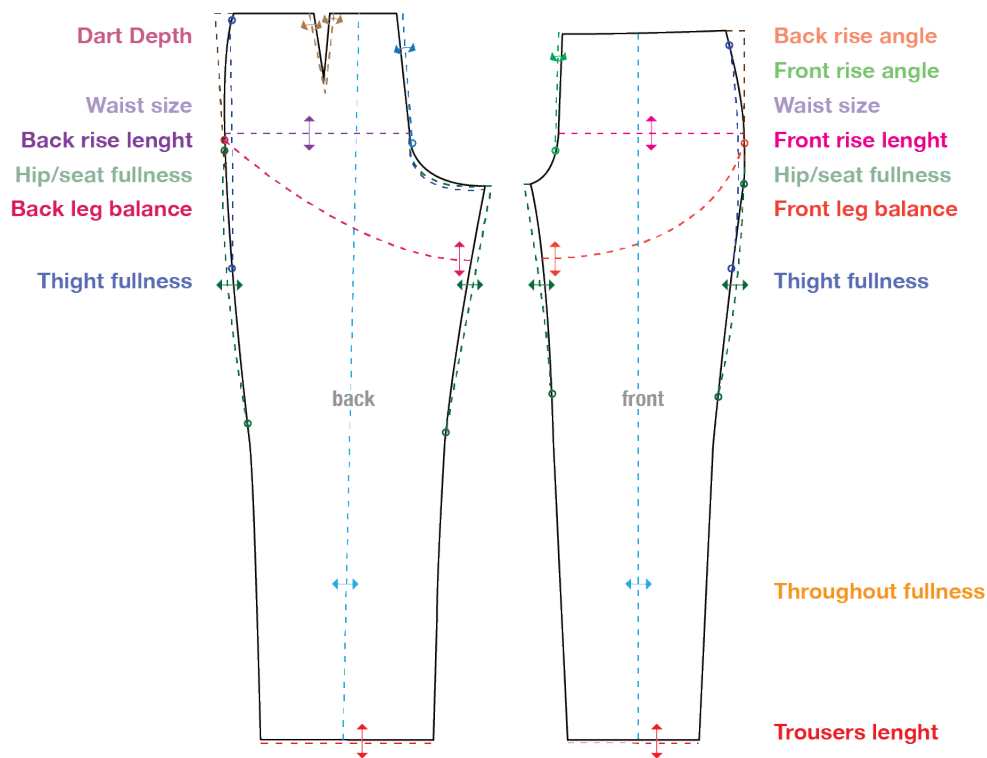
Figure 6 Common trousers pattern alterations– Tiina Ree, based on (Alto & Palmer, 2003; Dunham, 2021; Aldrich, 2008; Smith, 1979)

The standard trousers fit issues are around the waist, hip, and thighs based on the evaluation from the sources. Those are also the areas where the trousers are most closely fitted to the body, and the complicated three-dimensional shape of the body makes appropriate fit harder to achieve. On the other side, the aspect of the waist, hip and thighs common fit issues are caused by users' different body sizes and shapes.

Fitting experiment

To validate the fit issues alteration areas on trousers an experiment was conducted (process photographs on appendix 3). Due to the different grading methods, a base size of trousers (women's size EU 36) is used for further testing and development. For the experiment a basic pattern was constructed based on three body measurements, after

which, the sewing pattern was changed based on the fitting alterations to achieve well-fitted trousers for the model body. Base size trousers are used to limit possible incorrect grading for bigger and smaller body sizes. The fitting process indicated the complexity of the fit process based on using three measurements (waist hip and inside leg length), which do not consider the model's body shape.

The experimentation demonstrates that adjusting ill-fitting trousers would require re-cutting the trousers from scratch. Therefore, adjustability should be constructed into the most common areas of the trousers where alterations are made. The experiment also showed that the pattern adjustment suggested for standard fit issues in figure 6 are similar to the areas adjusted during the experiment. However, as the seams positioning of trousers is often similar, some of the areas where seams are could be the area for adjustments.

5.2 Ways of improving trousers fit

Trousers could be adjusted via different methods previously used in design, construction and by consumers to adapt trousers to accommodate their body sizes. In the following section a standard design, manufacturing and construction methods, and consumers' do it yourself (DIY) methods are viewed, to understand which common methods can been used to adjust the fit of trousers.

Fit adjustability methods in manufacturing

Custom made garments methods based on individual body sizes are standard in brands offering custom and made to measure services. The customer-specific and individual measures are used to adjust the base of the pattern prior to cutting the trousers. This service allows customers to have a garment specific to their body and size. Traditionally, the tailored garments included extra seam allowance to allow for further alterations during the garment use life.

Added stretch in garments is added to many textiles for a comfort element and flexibility for the fit. However, the problem with the stretch is the longevity of the stretch properties, as over time the elastane is relaxes, and the residual extension is higher (leaving the material to stretch out), resulting in the garments losing their original shape and elasticity characteristics. In addition, as elastane is often added to fabrics in a low percentage, the added stretch makes the otherwise mono-fibre fabric non-recyclable.

Design fit adjustability methods implemented in the design processes are being used as a design element of trousers. Classically waist adjusters (figure 7) and other waist size controlling methods have been used (drawstring waistband, elasticated waistband).

Figure 7 Trousers with side adjusters (Meiko Tailor, 2021)

Adjustable elasticated buttoned waist is used for boys' uniforms, where elastic is buttoned to a specific buttonhole to control the waist size (figure 8).

Figure 8 Waist-size adjustable trousers waist mechanism (Khundi, 2009)

Fit adjustability through construction are used for adjustability through adapting the construction of trousers. The commonly used methods are to add pleats or darts to the cut of the trousers, add additional seam allowances and extensions for alteration purposes on the back seat seam inlay and other seams of the construction. In addition, a patented waist adjuster slider (Toyoda, 1974) from the 70s has been used as a more technical mechanism for adjustability (figure 9).
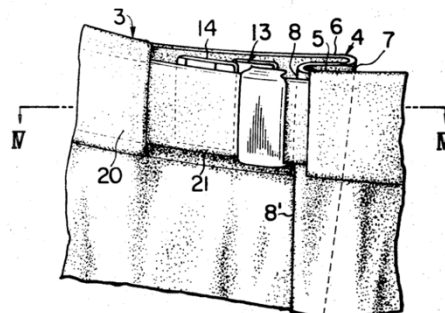

Figure 9 Waist-size adjustable trousers waist mechanism (Toyoda, 1974)

Do it yourself methods are used to adjust the trouser waist size. The methods are based on consumers' initiatives, where different sewing methods shared on various platforms are use creative ways to adjust the size and length of the trousers by adding (Figure 10) or reducing the fabric. Additionally, sewing solutions with external tools for adjustability are used to adjust the construction and alter the size.

Figure 10 Trousers fit adjustment methods by consumers (allfreesewing, n.d.)

Additionally different fixture mechanism are sold to consumers, the fixtures as buttons or hooks (figure11) can be added by consumer to the trousers to add the possible adjustability.
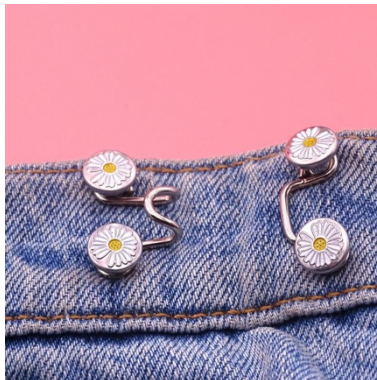
Figure 11 Trouser waist adjustment button (Joom.com, n.d.)

Presented options for fit adjusting are not commonly practised, as they require a specialised sewing skill, or the adjustability design is only added to the waist area. However, the standard adjustability requirements are more than only the waist. Additionally, the design methods have a substantial aesthetic impact on the trouser design, which can be unsuitable for all trousers designs.

From looking at the construction research together with ways to add adjustability to garments without using elasticity or stretch properties, a conclusion can be made that the main areas which commonly require alterations on trousers are waist, hip, and thigh areas.

5.3 Solutions for improving trousers fit

The concept development based on the research for improved fit explores the areas and methods for adjusting the fit by a consumer, or a method requiring additional service. The three most promising ideas were selected to showcase the different possibilities while analysing their strengths and weaknesses. The concept development methods follow four main principles:

- allows the adjustment of, at least: waist, hip, and thigh size
- does not use stretch or materials including elastane or stretch
- allows users to adjust the fit by themselves or using an additional service
- allows for the reversal of the alteration for the following possible user.

5.3.1 Solution 1: Thread pull

The pull-out thread concept is based on seam construction (figure 12). Chain stitch seams have a property of easy removal, as one specific thread controls the chain. Undoing seam can be used on trousers construction, where three or more lines are stitched next to each other with allocated spacing, allowing a user to act if the trousers are small and pull out one of the stitch lines to allow more space.

While an easily used solution, adding back the seam would require specific machinery and skill should a user pull the wrong seamline. Additionally, the seam can leave puncture holes in the fabric, or because of the previous wear, the visible/exposed trousers fabric has been faded, and after undoing another seam, an area of colour disparity would be seen.

On the positive side, the user can control the adjustment fully by themselves. However, the possibility of redoing seams could end up with the customer discarding the trousers due to a mistake made in the adjustment process.
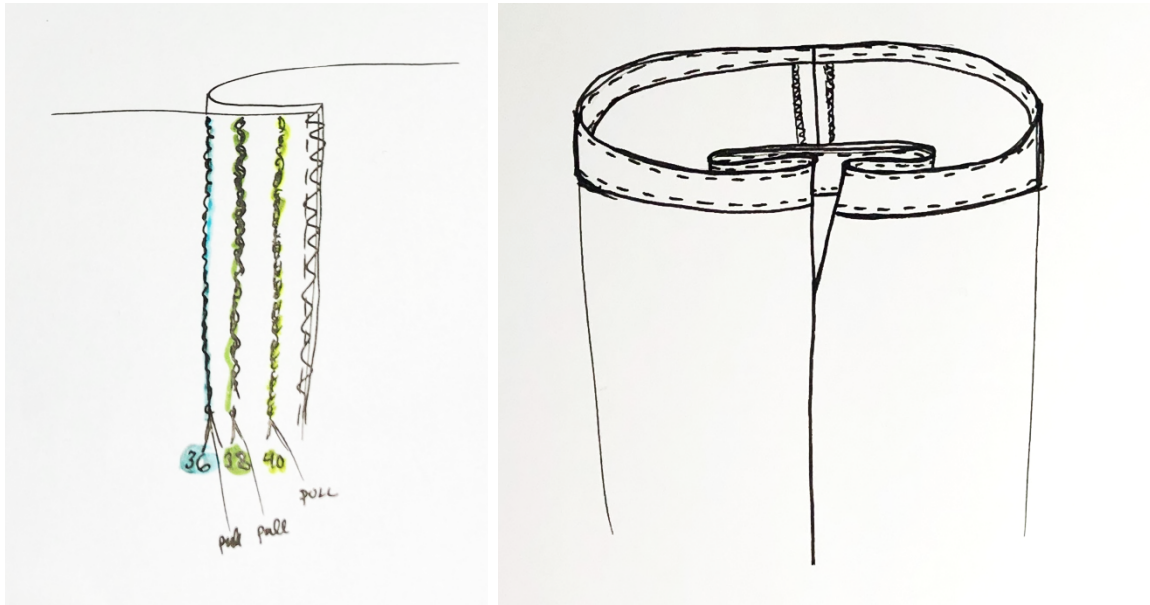
Figure 12 Solution 1 Thread pull adjustment mechanism sketch – Tiina Ree

5.3.2 Solution 2: Method of extra seam allowance

The second method is adjusting the construction of the trousers by adding a space for internal construction. The extra seams allowance (figure 13) allows adjustability of fit by alteration services. The trousers' internal seam allowances would be placed on the common alteration areas with a visual indication for the specialist to follow based on the customer's body dimensions and shape. The user would need to use an additional service, creating another touchpoint after purchase or use. For example, the alteration services are not fully available, plus would need to give alteration services some direction or guidelines. The after-purchase requirement would add a cost to the product. Subscription-based alteration and repair services could be an option.

On the other side, the additional service provider visits could be data collection places, where repair and alteration services give the data to the brand. Upon obtaining this data, brands can analyse and utilise it to improve future production. This creates a continuous improvement loop for garments based on consumer data that manufacturers and designers can use.
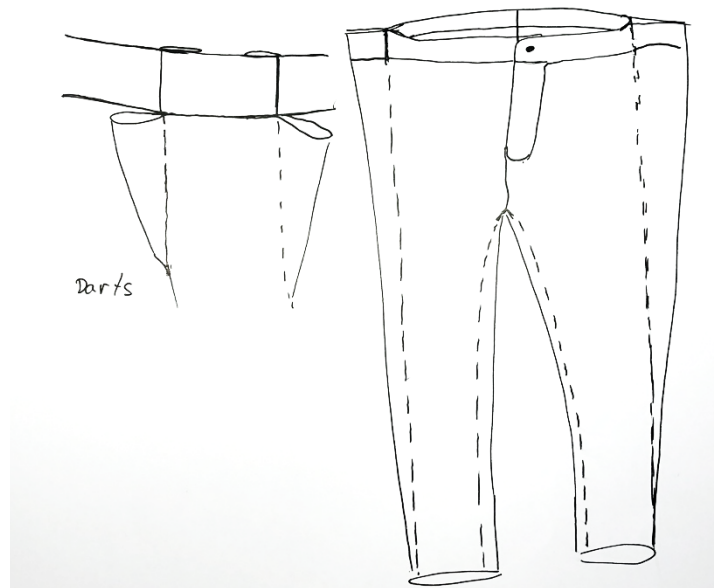
Figure 13 Solution 2 Extra seam allowance mechanism sketch – Tiina Ree

Similarly, to the first solutions negative points, the solution for extra seam allowance constructions after alteration could leave marks on the garment. Puncture holes from the needle revealed by unpicking and re-sewing the garment and the possible fading lines contrasting on the seams could be an issue. From the construction of the trousers, some of the classical trousers' seamlines would require repositioning due to the physical limitations. For example, slits would need to be cut into the seam allowance to form the 3D shape on the inverted curves. However, requiring additional services for alteration, the visual signal for the consumer (that the garment is adjustable) could be an educational tool for the users to demonstrate the alteration possibilities.

5.3.3 Solution 3: Method of buttoning through slits

The third solution is a method where the areas can adjust by gathering or widening the area by a button and a buttonhole mechanism (figure 14). This method is adaptable for many seams and is easily changeable by the user. The ease of use for the consumer and the familiarity of buttoning are great strengths of the solution. As well as the aspect of self-maintaining a garment, as sewing button back is a skill that most consumers are familiar with. Therefore, in the case of fixture's breakage, a user can fix it themselves.

Depending on the fabric used for the trousers, the mechanism construction can be bulky and hard to fix. However, the ease of use and familiarity of the mechanism is a positive aspect, which, as well as adjusting the fit, also leaves an impression that the fit change is easy, which can be a positive habit change, where the user gets used to adjustable fit garments. Therefore, a possibility of spreading the idea to other types of garments.

Figure 14 Solution 3 Button thorough adjustment mechanism samples – Tiina Ree

Due to the lack of additional service requirements for the consumer, the third solution is chosen to be the best option to continue the adjustability mechanism development. Furthermore, considering the possibility of actual benefit for the consumer in the use phase of the garment, the mechanism the consumer can easily adjust is taken as the main attractive characteristic of the three proposed solutions.

5.4 Testing solution 3

A prototype has been created (figure 15) for testing purposes. The prototype has an adjustability mechanism added to the waist's front pocket and an upper back leg (figure 16). The trousers fit developed based on a model used for the fitting experiment presented in section 5.1. The base trousers pattern was altered to include an adjustability method on both legs' front pocket opening and back leg area from the waist to the knee.

The test sample is designed to have classical trousers design elements. It uses a neutral fabrication to draw attention away from the tested garment's appearance and emphasise the adjustability mechanism, i.e., keeping the objectivity of participants' opinions without achieving the trousers' dislike by visual style and appearance

preferences. The sample uses 100% cotton fabric without remarkable natural stretch properties.
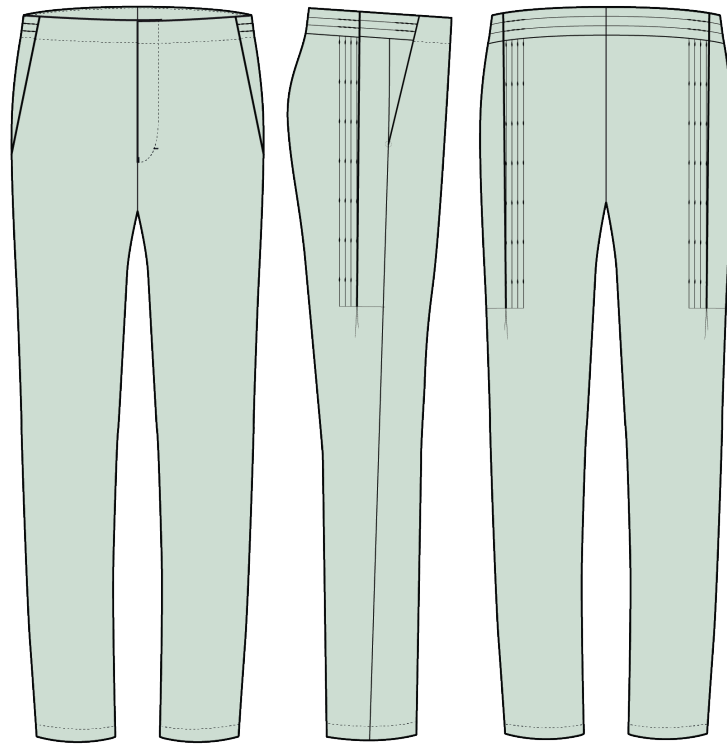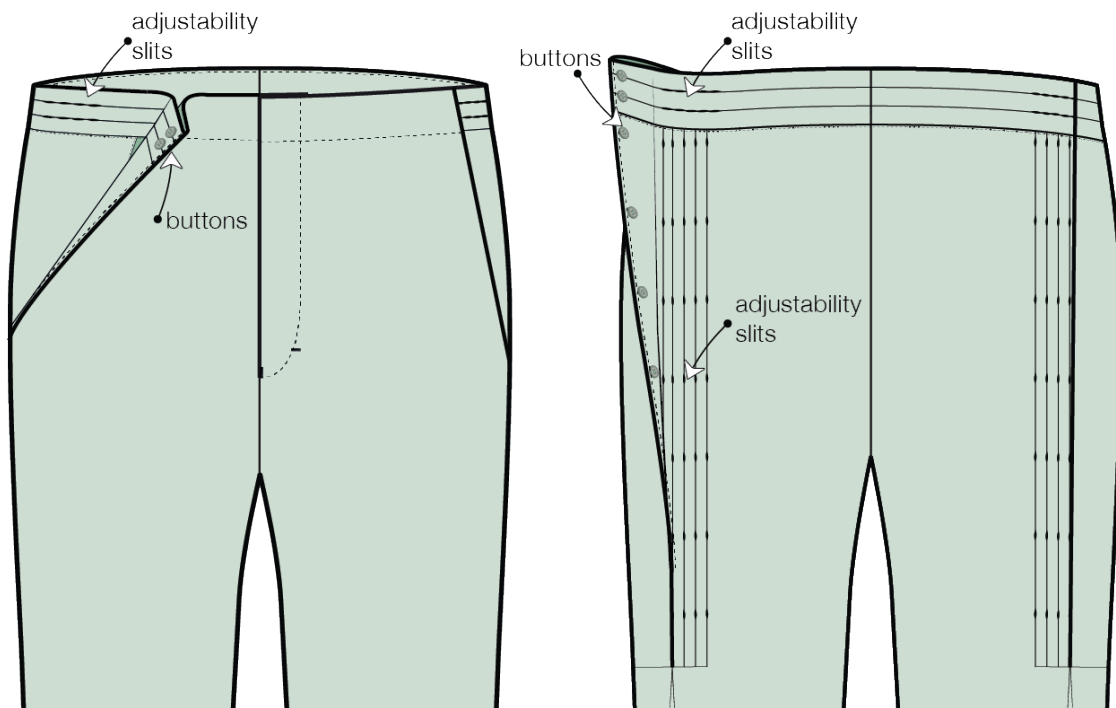
Figure 15 Prototype technical drawing – Tiina Ree

Figure 16 Prototype adjustability mechanism – Tiina Ree

The garment construction mechanism allows the user to change the garment to accommodate to their body. The trousers are constructed with additional construction

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elements on the pocket opening and upper back leg. The back leg adjustability added by the panel construction enables the user to change the trousers fit according to their body shape, from the hip and thigh. In addition, the construction change on the front pockets allows the waist to be adjusted. The adjustability method is based on the lower and upper panels. The lower panel consists of buttonhole-like slits divided by 0,5cm distance. The upper panel consist of a button, which connects to the slit. By adjusting the button to a farther or closer opening, the user has space in the trousers.

5.4.1 Test results

The prototype was fitted on five participants (A, B, C, D, E) of different body shapes across men and women (figure 17). The participants were chosen from people who generally wear size EU36 women or equivalent. The prototype is tested on various body types and shapes to explore the feedback and further development needs and opportunities.

The testing aimed to:
- test the physical mechanism of the adjustability
- test the suitability of mechanism placement
- gain feedback for the concept of adjustable garments
- understand the benefits and participants' experience of the opportunity to adjust the garments to fit their bodies' size and shapes.

All participants voiced the comfortability of when the trousers were put on. The participants appeared positively surprised by the comfort and fit aspect of the trousers, even though knowing the trousers were tailored to someone else body type and measurements. The adjustability mechanism functioned well to fit the participants' size. However, the mechanism took time to adjust due to the make of the slits. The back leg adjustability panel placement did not allow a participant to adjust the trousers while wearing them. The participant needed to take trousers off, adjust, and then put on trousers to adjust the back area. Off body adjusting can be inaccurate, and then adjusting and trying on would need to be repeated many times, thus not effortless for the wearer. With current back leg adjustability positioning, body size adjusting required extra help. Henceforth the back leg mechanism placement would require moving to the area where it is adjustable for the wearer while wearing the trousers. The front pocket adjustability mechanism is easy and comfortable to adjust.

Figure 17 Prototype on participants A, B, C, D, E

The trousers fit on after the adjustability is similar to all participants (additional photographs in Appendix 4). Regardless, there are slight fit issues on the front crotch and back seat area, given that as the fit issue is on all participants, this can be due to the prototype sample cut, which would require an additional pattern adjustment to achieve better results. Therefore, additional testing is required, where two identical trousers are compared on the same model, one trousers with an adjustability mechanism added and the second without. Yet, as this testing aimed to trial the mechanism functionality and general concept, the comparative testing was not done.

Participant B finds the trousers' adjustability mechanism to be an additional benefit, as they often have an issue finding trousers that accommodate their seat area and waist size differences. Participant A has an issue with trousers generally on the thigs and waist area, where most of the trousers are too tight on the waist and thighs, however, fit on the seat. Henceforth the adjustability mechanism would eliminate this issue. In addition, the Participants voiced the benefits of second-hand shopping where different brands are sold together (same size label but different measurements), and the adjustability would make it easier to find well-fitting trousers from the resale market.

To conclude, testing trousers fit adjustability on the front pockets and the back leg is successful. The testing on the mechanism and concept is positive. Adjustments to back area mechanism placement and further testing are required to improve the mechanism.

6 DESIGN CONCEPT

The fast-fashion system produces low-quality garments that are not valued in the use cycles. The garments are discarded partly for the garment fit issues, which are not accommodating consumers' various body types and changes. The fit issue is visible in trousers, selected as an example for the concept development. To avoid more garment waste produced, the aspect of what is and why it is manufactured should be reflected from the product creation stage. The system should be adjusted according to the new product. Indicating areas on the product, supported by the system, to encourage the longer use life of a garment. Elongating the garment use life for consumers by adding an adjustability mechanism to improve the fit of trousers would require an additional change in the system to accommodate the requirements for the multiple-use cycles. Elongating garment life through adjustability and improving the infrastructure for collection, sorting, and redistribution can strengthen the reuse and longevity of the garments as well as strengthen stakeholder collaboration.

The idea is not to develop a structure that allows garments to have a one-size-fits-all solution. One-size-fits-all is also considered a design flaw based on the Principles of Green Engineering (Anastas & Zimmerman, 2003), as it is using unnecessary energy and materials for the need that the end-user does not require. The additional functions to the product should enable the improvement of realistic use-cases and required satisfaction without overcomplicating the product to the level that the over-designed usability is not necessary. The idea to add fit adjustability to the garments is to improve the fit to a specific size of trousers to adjust the comfort and fit, but not to design a garment that accommodates a vast range of body types and sizes.

The developed concept is called *Uuse* (figure 18*)*, combining words *uus* (*new* in Estonian) and *use*, to emphasise the multiple n new opportunities for the use of the garment by numerous users.

Figure 18 Uuse name explanation.

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6.1 UUSE

Uuse is a construction method concept for planning and developing clothing that fits the system as well as consumers. Uuse adjustability concept creates added value for clothing. The garment created with the Uuse concept allows the consumer to adjust specific details according to their body type throughout the garment's lifespan. Allowing the clothing to be adapted to the body type and size gives the customer confidence that the purchased clothing will fit their body. Adjustable clothing is suitable for reuse and multi-user consumption systems, eliminating the possibility that the user will abandon or lose value to the garment because it does not fit their body type or is not comfortable to wear. The adjustability through the fit adjustment mechanism allows the garment to be perfectly fitted for many users and is suitable for business models (for example, renting). By increasing the number of downstream clothing users, the service life of clothing is extended, and less clothing ends up in landfills or stays unused in wardrobes. The need for material to produce new clothing is reduced. Brands can adapt their business model to care for and repair their clothes instead of producing new garments that are not valued and are quickly discarded. The Uuse concept allows the development of garments that perfectly fit the customer and the system.

Uuse concept is divided into two:
- Garment adjustability mechanism for applying to garment construction.
- A suggestion of shifting the business models towards developing collection and redistribution systems which are supported with care and maintenance services to encourage the reuse of garments.

The Uuse concept encourages longevity and circularity, slowing down the consumption and increasing the value of the garments circulating in the system. The future of fashion sustainability requires a change from the product and system combination perspective to achieve set goals for more sustainable consumption and adjust to developing business models.

6.1.1 Adjustability mechanism

Uuse adjustability mechanism is a concept for garment construction and development methods that, by adding extra functionality for the construction of trousers, allows the consumer to personalize the size of specific garment area to suit their body type.

The Uuse adjustability concept is developed for trousers. Trousers developed with the Uuse adjustability mechanism are adjustable for three areas of the body: waist, hip,

and thighs. In the trousers (figure 19), the waistband area (through front pockets) is reconstructed to allow the waist to be adjustable. The trousers' side seam is reconstructed to allow an extra panel, by which the hip and thighs area of trousers are adjustable for the consumer. The Adjustability mechanism can be added to include the adjustability to trousers with various designs, and the mechanism is independent of the style of the trouser. Therefore, the mechanism is an addition to the construction and does not have a high impact on the trousers' appearance. Hence, allowing the adaptability to different styles of trousers. Therefore, it is a construction element, not a design statement.
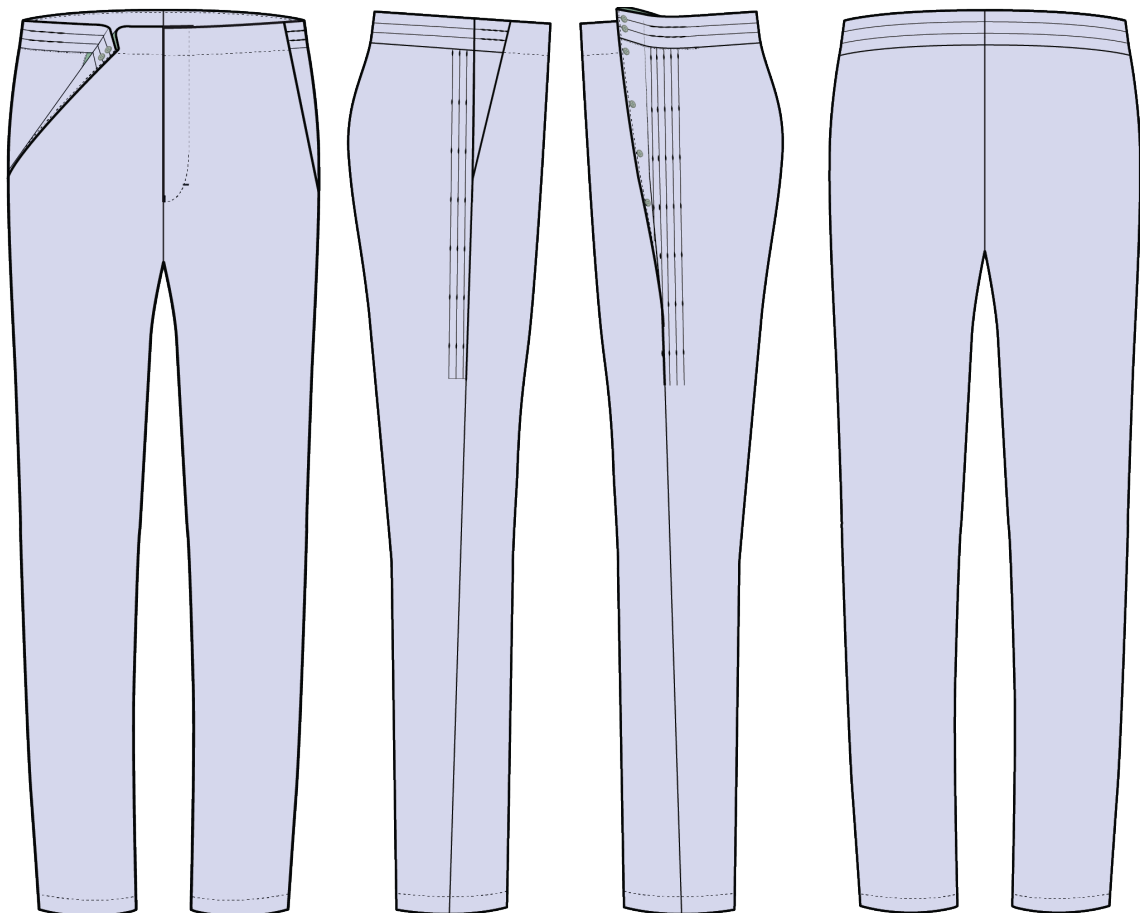
Figure 19 Uuse adjustability mechanism on trousers – Tiina Ree

The adjustability mechanism is constructed from two sides, a top containing a fixture, and a bottom side, which is developed depending on the fixture type to attach the fixture in place. The initial proposed design contains a button and seam-slit construction developed based on solution three offered and tested in section 5. The button and slit adjustability design fixes the button to a specific slit to achieve the required size of the adjusted area on the trousers' waist, hip, or thigh. The consumer can adjust the trousers' side depending on their body type and size and personal preference on the tightness and comfort of the trousers.
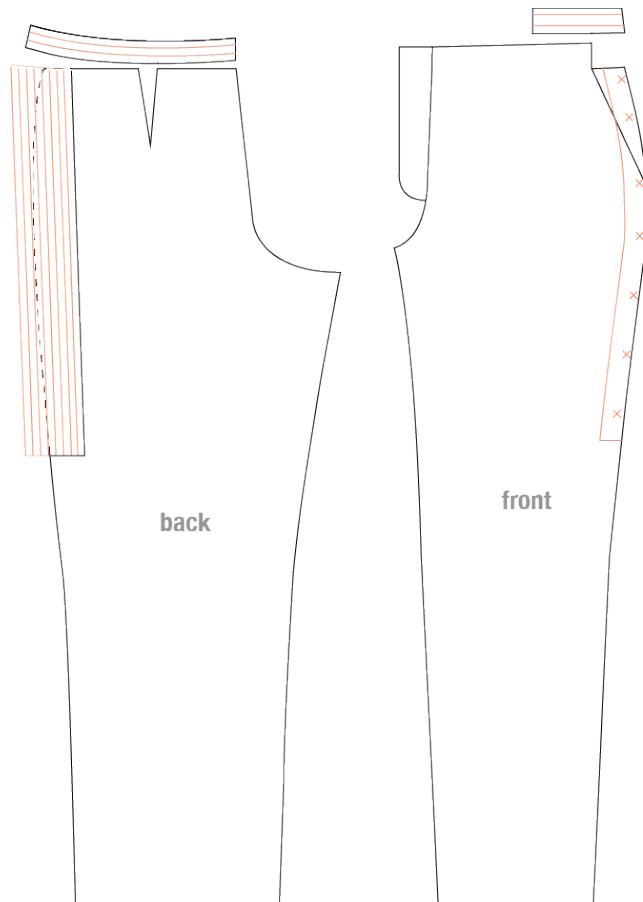
Figure 20 Uuse adjustability areas on trousers pattern – Tiina Ree

The adjustability side seam construction is added to a trousers pattern as illustrated in figure 20. The panel is connected to the side seam by adding an extra cut piece connected with a seam construction explicitly developed for the slit-button method. The trousers pocket opening waist adjuster is developed as a construction transformation for the pocket, where the waistband and pocket bag are connected, as shown in figure 21.
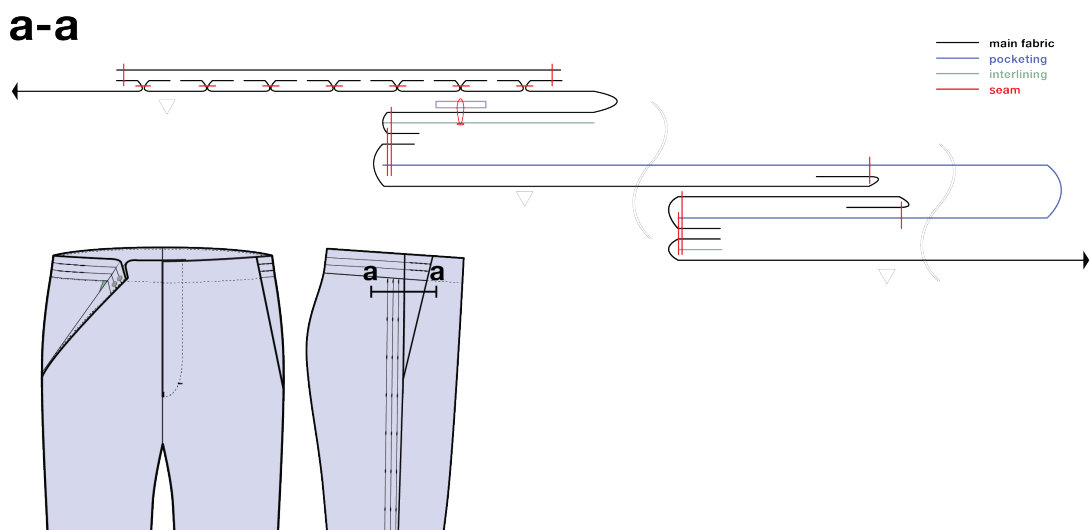

Figure 21 Uuse trousers waist adjustability mechanism construction – Tiina Ree

6.1.2 System

The system would need to be adapted to support the product in addition to the product change. To eliminate the case where the garment is discarded without having the full potential in the system. The system needs to change according to the product to support the adjustable product to maintain the possibility of redistributing the product to the following user after use. The areas of disposal (fit, perceived value and intrinsic quality) would need to be supported by the system as well. The new system map is drawn out to present the improved system functions and flow (figure 22). To ensure the trousers with Uuse adjustability construction do not end up in landfill and the reuse is encourages, the system development is needed three main areas for supporting the continuous reuse for garment longevity:

- **Redistribution models** - To promote garments' reuse, a resale platform would need to be a regular part of brands' sales strategies. As well as offering different consumption models such as rental and leasing.

- **Collection and sorting** - Developing a proper collection facility where garments are checked, maintained and redistributed to the correct distribution channel or remanufacturing or recycling.

- **Feedback loops** - Communication feedback data from use and maintenance for garment creators (brand and designer, textile, and garment manufacturer). Additionally, to the infrastructure of garments distribution, a collection of data channels should be developed between the sorting centres and brands. Create a feedback system where the user can give feedback directly on the brand regarding the garment's quality, life cycle, and durability. The brand can use this information to develop products and services further

The updated garment journey in the system starts with the creation phase. The brand and designer designed the garment by using the Uuse adjustability mechanism added to the garment construction. The designer has updated the mechanism design according to the garment style by choosing appropriate design, materials and fixtures. The garment construction is developed in collaboration with the garment manufacturer. The garment is manufactured and distributed to the sales channels. The consumer purchases the garment and tries it on, and the user experience is higher. The chance that the garment is not well fit for the consumer body is reduced. The increased purchase moment reduces returns to the brand. The increased user experience increases the user relationship with the garment, though also the emotional connection and value to the garment increases. A higher possibility that the consumer will take better care of the

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garment. When the user has finished using the garment, they can give it back to the brand or collection centres or sell them by themselves to the next user. The collected garment, when going through the collection centre, is overlooked for quality, failures, and usability. The garment is redistributed back to the sale, remanufacturer or recycled, depending on the garment quality. As most of the garments will go through the collection centres, there is a possibility to collect the information on garment quality and evidence from use life. The data can be distributed to the material and garment manufacturers and the designers, who can use the data to improve further production. If the garment is suitable for reuse but has some maintenance needed for repair or cleaning, the sorting centre applies the needed maintenance on the garment from where it is distributed back to the sales models, from where the following user can access the garment. The system's circulation would be better, and the discarded garments (as going through the collection services) will end up in the correct places (resale, remanufacture or recycle).
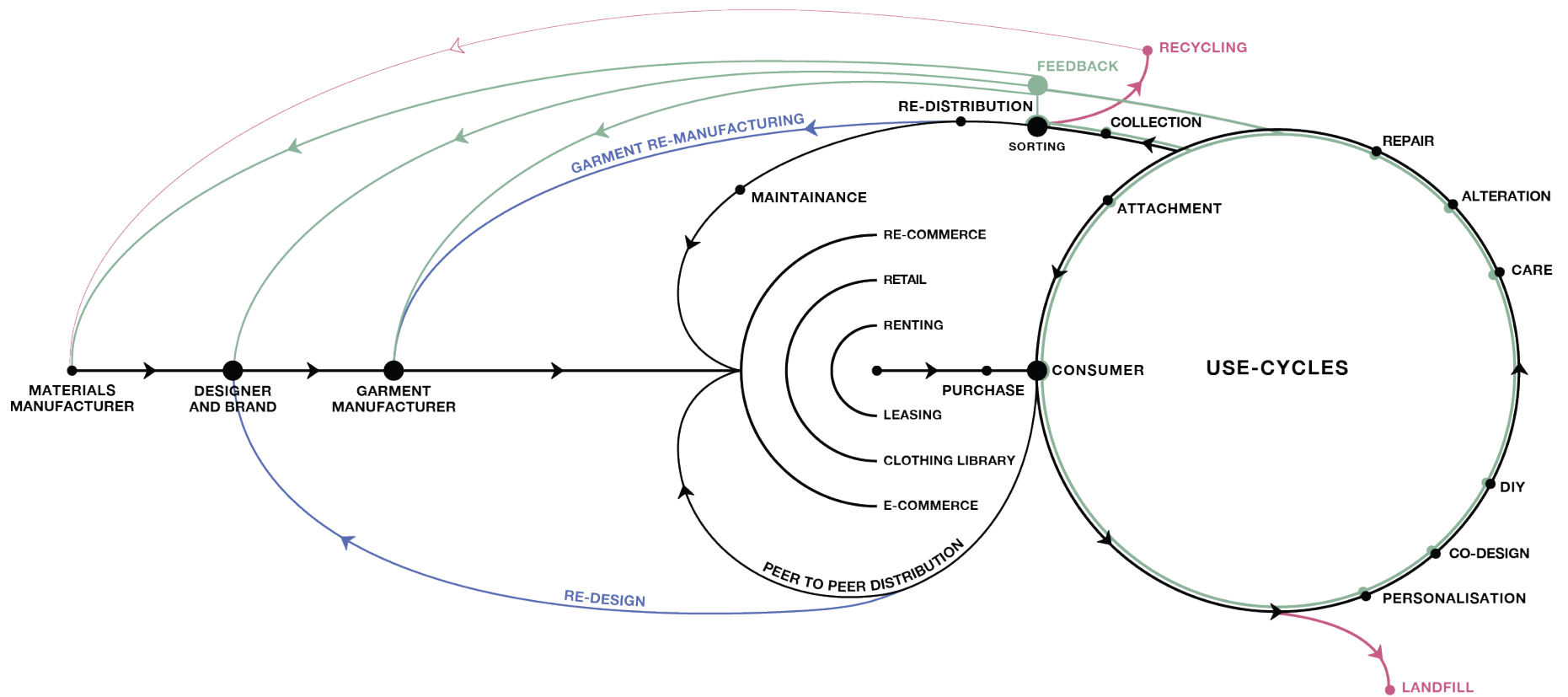
RECYCLING

FEEDBACK

RE-DISTRIBUTION

COLLECTION

SORTING

GARMENT RE-MANUFACTURING

REPAIR

ALTERATION

MAINTAINANCE

ATTACHMENT

CARE

RE-COMMERCE

RETAIL

RENTING

USE-CYCLES

CONSUMER

LEASING

PURCHASE

CLOTHING LIBRARY

DIY

E-COMMERCE

CO-DESIGN

MATERIALS
MANUFACTURER

DESIGNER
AND BRAND

GARMENT
MANUFACTURER

PERSONALISATION

PEER TO PEER DISTRIBUTION

RE-DESIGN

LANDFILL

Figure 22 Uuse system map -Tiina Ree

6.1.3 Changes for stakeholders

Changes for stakeholders by the system and adding a product and additional functionality, which allows its different use causes a system change also affect the stakeholders' role. Furthermore, to accommodate the functioning system, the stakeholders should also adapt to the system changes.

Changes for the brand would be more included in the garment lifecycle. As the brand business models would offer different sales models, the sold garments can be supported by offering maintenance services to the consumers to support the longevity of use. In addition, the brands would offer support or organise the collection and sorting of used garments and organise the maintenance with the manufacturer.

Changes for the manufacturer would require adding remanufacturing and maintenance to the business model. As the garment manufacturer has the skills in sewing and knowledge of garment construction, they can be a part of the maintenance services. In addition, the quality control done in collection points can be used by the garment manufacturer's skills.

Therefore the shift from only creating new garments and moving to offer supporting services throughout the garment lifecycle would be required for brands, designers and manufacturers. The creation part of the system develops into the creation and care of the garments and the consumer.

Changes for the consumer through the improved system and garment construction changes to adapt the adjustable fit to garments. Support consumers different consumption models, allowing people with different consumption habits and needs to consume sustainably, as the system and clothing creators (manufacturers, designers, and brands) have created garments suitable for their needs and habits. The system and product improvement affect the consumer consumption habits and shift the value of materialism and owning to a sharing economy, collaborative consumption and culture of care. Better fit experience. Adjustable fit clothes will make users feel better about their bodies.

Changes for the environment – the continuous improvement of the product quality and improving the redistribution and resale can positively impact the environment as fewer garments are created, creating better and longer-lasting garments. The idea reduces the number of garments in circulation and reduces the production of new garments. As production is more expensive and time-consuming, the energy used per

product is reduced mainly in waste treatment (less discarded clothing) as the lifespan and value of the clothing are increased. Which reduces overall production resources (producing less and more as planned). The environmental issues can shift to the other areas where the improvement is needed—improving the garment cleaning processes and the distribution effect on the environment.

6.2 Evaluation

Consumers and specialists evaluate the Uuse concept's feasibility for commercialisation. Based on the prototyping testing phase, the product's user feedback is relatively positive. In addition to the feedback collected in the product testing phase, the concept's feasibility is evaluated by specialist interviews with professionals working in the industry. The specialists were chosen to cover different stakeholders in the system: manufacturers, designer, and specialist. The feedback was collected by presenting the main ideas and outcomes of the thesis with a visual presentation in an online video call or in-person format, which was followed by feedback and comments from the specialist, which are presented below.

Evaluation interview with expert, researcher and consultant on circularity in the fashion and textile industry. - online-videocall interview, duration 45 minutes.

The tackled issues are very relevant to the fashion industry, as the fast fashion garments are not high quality and from a fit aspect, which affects the aesthetics. The fashion system mapping is thought through. However, the system can not be changed with one model. Different aspects should be concentrated on at the same time.

The system would need to incorporate the extender producer responsibility and the different EU strategies and initiatives. The need for solutions for creating better garments is very relevant. The legislation and complete system change would need to support it. Currently, the used garment collection and sorting centres do not have processes and practices in place.

The aspect of the adjustability mechanism would need further research to look at which category and function garments it would be added on to understand which garments require adjustability.

From the system view, the aspects and responsibility of the brand need to be further developed as they are the one who has the power in the system. The brand and designer responsibilities would need to be more substantial and visibly mapped out.

Traditional made to measure clothing manufacturer – in person discussion with general manager and production manager, duration 50 minutes.

The traditional made to measure manufacturer business is similar to Uuse proposed method, where a manufacturer is part of the care and maintenance services to support the garment lifespan. The garments are often sent back from the consumers and repaired or altered in by the manufacturer. The service is often used, even the service is expensive. The garment adjustability concept is not seen ad added value to the specific traditional costumes, as they already have a traditional extra seam allowancing across the garment, and as the garments are made to measure specifically following customers measurements the garment fits for the user. The improvement from the idea is seen to the comfort and during wear adjustability ability for wearer. The indication of going back in tradition where garments had a multi-use due to the very high material cost and garments were constructed with additional seam allowance and the garment was handed on to next user and therefor altered for them. The possibility of how to encourage fast fashion business model to change was questioned.

From the system point of view the manufacturer does not see their skilled workers moving to used garments quality control and repair, due to the possible hygiene issues that can be caused by worn garments. Therefor the discussion highlighted a stigma on being in contact garments which are worn by someone else.

The potential is seen for easier garments construction such as skirts and shirts. The construction would be thought through for big sizes, as the placement of the mechanism could require an additional proportional consideration.

Ready-made garments manufacturer – in person discussion with sales manager and production manager, duration 70 minutes.

The adjustability mechanism is found as an interesting new construction element for garments. The aspect of construction design is as if the designer wants it on garments, the manufacturer will make it happen. As the manufacturer produces technical garments, the adjustability mechanism would suit well to their product category. Brand and manufacturer would require having a good relationship to develop the mechanism depending on the produced garment. To develop a suitable mechanism for the specific garment function and appearance, an extra development team would need to be on the brand or manufacturer side to allocate the development process. Alternatively, the development process can be outsourced, adding another stakeholder to the system as product mechanism development. The product's development cost will go up, and the manufacturing cost. However, the price can be equalled towards longevity and multi-

users. The quality should be enough to consider the price. Technical products generally have more trust in quality, and the mechanism would suit there.

From the system point of view, the question lies in who will organise the money flow. As a repair, collecting and sorting services are time-consuming and expensive to offer. Government funding and support would be needed to initiate the change. If the manufacturer would repair garments they do not produce, it is not possible to test the fixing method on the garments, and incorrect or suitable repair methods can cause garment waste. On the other side, the skill and workers' movement from factory to sorting quality control and repair is reasonable. Frequent feedback from sorting centres to the manufacturer is not seen as a high value, as the brand would still lead the decisions. However, it can be used for learning and information processes to guide and give feedback to the brand on what could be the improvement. The system would work maybe after some time. The Estonia market is not seen as a potential, as the consumer's culture might not be ready for reuse and collaborative consumption. A consumer education would need to be placed together with improved garments and systems to communicate the new business models.

Evaluation interview with slow fashion brand- in person discussion with brand designer/owner, duration 60 minutes.

From the designer' perspective the adjustability mechanism concept got a positive reaction. The main point for the designer point of view would be the adaptability of mechanism design for the brand and garment aesthetic properties and to have a wide range of possibilities (for the adjustability design) to choose from. The offered adjustability mechanism would require a concentrated development before it would be able to use. Therefor a complete product development of the mechanism and research on the need for adjustability areas for different products. The brand would require a specific description on:
- the exact areas the adjustability would be placed on garments
- selection and description of possibly used fixtures (zips, buttons, hooks)
- which garments it can be used, and where are the needed adjustment areas and research supporting why.
- The mechanism would require a manual, which brands can use for putting together explanation materials for consumer.

From the system point of view looking at the designer expanded role in across the garment lifecycle was discussed, the main points for further consideration, especially for smaller brands are:
- economic opportunities to offer different clothing distribution methods

- as the brand buys in a manufacturing service, the brand do not have seamstresses, therefor the repair service offered for collection and sorting points as well as maintenance services offered during garment use-cycles would need be separated from the brand.

7 DISCUSSION

The research answers the question, "How can changing garment construction elongate garments' lifespan and increase the potential for reuse?". Adding an adjustability mechanism into the garment construction can support the garment's lifespan and increase the reuse potential. The garments' adjustability function adds potential to a longer lifespan and reuse possibilities if the system accommodates the reuse and longevity. The successful lifespan elongation can be done in a system supported by support structures and services.

The product and the system should be looked at as one—systemic product change to fit the system innovations. Without a supportive system, the sustainable product might not have a sustainable end of life journey, as the services do not support the reuse and elongation. The system, especially brands, would need to step up and improve the responsibility of the produced garments. The legalisation and innovation of how to make better garments and how to ensure the better and longer use life of the garments in the system is a question that should be concentrated more.

7.1 Future of the project/research

At this point of the research, the concept of Uuse is developed for trousers, with implications for the general fast fashion system. Given the development of the study, case study-based testing would require testing the concept's suitability in a practical design and production process. The adjustability mechanism has the potential to be redesigned from the button attachment for a more robust fixture design.

As the adjustability concept is adaptable to other garment categories and designs, further development of garment specific adjustability methods is an area which could be further developed to expand the Uuse trousers adjustability mechanism. In addition, there is a possibility of developing an additional general function to basic clothing types, easily addable to the garment patterns in development processes.

Further calculation of the environmental benefits of the concept is needed to evaluate the environmental implication of the concept. For example, consider the manufacturing, retail, use and maintenance, and redistribution processes and their effects on the environment.

From the system perspective, further research is required to understand the possibilities and areas where collection and sorting services can be better integrated into the system. The system change aspect is an area which by supported legislation and stakeholders, especially brand initiative and motivation is needed.

7.2 Contribution to the field

The thesis opens up a discussion on garment fit concerning the systemic garment sustainability strategies in the fashion industry. Mapping out a fashion system and indicating the disposal aspects contribute to the overall sustainability discussion. Considering disposal reasons in the sustainable product development is an area that needs more research and attention. The systemic view on introducing an adjustability mechanism for garments can be a new sustainability aspect that brands can adopt in their product design and development decisions. Aspect such as improving the distribution and resale models and investing in sorting and collection centres is an area that is essential for a sustainable fashion system development. The thesis recategorizes a sustainable strategy from commonly used product-service systems to reuse strategies (redistribution, value-adding and remanufacture). The mapping of the fast fashion system and construction improved systems is a valuable tool for rethinking the areas of holistic system improvement within the garment disposal reasons. The thesis contributes to developing additional sustainable strategies and encourages the discussion of the connection between garment fit and sustainability.

SUMMARY

The fashion industry represents one of the most significant contributors to environmental damage. The increasing speed of consumption and production has created a tremendous amount of garment waste in the industry. The fast-fashion linear business model causes the garment waste from production, consumption, end-of-use-cycle sorting, and collection – garments do not circulate in the system and are often quickly discarded.

Increasing consumer knowledge about fashion's wastefulness has pushed the industry to look toward sustainable strategies. Approaches such as the circular economy and slow fashion emphasise longevity and circularity, endorsing companies to improve business models by introducing rental, lease, resale, and repair services. Although sustainability efforts exist, they do not operate on a broader scale. In addition, sustainability discourse does not often emphasise the garment. While consumption and business models are improved towards sustainability, the actual product (i.e., the garment) has not been improved together with other system elements. This disconnect demonstrates that fashion sustainability improvement is not practised holistically, but rather piecemeal. This thesis undertakes to address this crucial disconnect, in particular, recentring the garment per se from the technical-methodological perspective of fit (i.e., how a given garment fits the body of a given wearer) to reframe more holistic models of fashion sustainability.

Diverse stakeholders in the industry – e.g., garment manufacturers, brands and designers, retailers and distributors, consumers, maintenance services, and collection and sorting providers – view sustainability issues from different perspectives, and the current fashion system does not foster transparency and collaboration. The product (i.e., the garment) represents the system's central component, functioning as a touchpoint with all stakeholders. However, despite this reality, the produced and distributed product is not perceived as a potential key to sustainability. This study brings garments into focus and examines the system from the perspective of the product, following its journey.

More specifically, questions of what motivates garment disposal – i.e., why a given consumer discards a given product – are also not considered an essential aspect of the sustainability discourse. Thus, a garment's perceived value, physical durability, and aspects of unsuitable fit still need to be mapped into sustainability aspects. This thesis, in contrast, examines in detail the phenomenon of garment fit as one of the top issues driving the problem of garment disposal, which in turn crucially affects fashion

sustainability. Causes of fit issues and subsequent garment discarding include the production of ill-fitting garments, standardised body shapes and measurements in product development, and changes in consumer body build. The challenge of fit related to sustainability is especially relevant in promoting multi-user garments. Here, the change in consumer and the dimensions of the wearer's body plays a significant role and can be a critical aspect of garment longevity and cyclability.

The present study develops an adjustable fit mechanism tested on participants, taking trousers as a case study since the trousers represent a particularly challenging product within the fashion industry in terms of fit. Furthermore, the research explores the trouser fit mechanism as a potential solution for reducing garment waste in the system by enabling greater prolonged use for single-use garments and improving the potential of reuse for multi-use garments with attending improved consumer experience.

This study explores the adjustable fit construction mechanism called Uuse to show the benefits of clothing adjustability and improve the system. However, for the system to adapt to the concept of adjustable garments would require improving collection and redistribution centres and services with support from a maintenance process. In addition, brands would need to offer alternate sale models (rental, lease, resale) as a regular part of their business models. Lastly, a feedback loop should be introduced to aggregate and feed data collected from redistributed garments back into and across garment creation processes.

The current study indicates the potential value of an under-researched area of garment fit for improving sustainable business models and consumption cycles. Although research results require further development, the substantial potential exists based on the study's evaluation. Adjustable garments can transform consumer garment perception (how consumers perceive a garment's value and utility) and how fashion-related businesses contribute to the system. The study offers a systemic modification for brands to shift away from merely garment production to develop business models across the garment journey, thereby supporting all aspects of the garment lifespan: creation, distribution, consumption, and maintenance of garment. Concept *Uuse* is a garment development to create adjustable fit products that fit perfectly with the system and consumers' bodies, ideologies, and lifestyles.

KOKKUVÕTE

Moetööstus on üks olulisemaid keskkonnakahju tekitajaid. Tarbimise ja tootmise kasvav kiirus on selles valdkonnas loonud tohutul hulgal rõivajäätmeid. Kiirmoe lineaarne ärimudel põhjustab rõivajäätmeid nii tootmise, tarbimise kui kasutustsükli lõpu sorteerimise ja kogumise etappides – rõivad ei ringle süsteemis ja visatakse tihti kiiresti ära.

Tarbijate teadlikkuse suurendamine moetööstuse keskkonnakahjust on mõjutanud valdkonda otsima jätkusuutlikke strateegiaid. Lähenemised nagu ringmajandus ja aeglane mood rõhutavad pikaealisust ning ringlust, mõjutades ettevõtteid ärimudeleid parendama, näiteks luues rendi-, liisimis-, taasmüügi ja parandusteenuseid. Kuigi jätkusuutlikkuse alased püüded on olemas, ei ole need laiapõhjalised. Lisaks ei rõhutata tihti jätkusuutlikkuse aruteludes rõivast ennast. Samal ajal kui tarbimis- ja ärimudeleid parendatakse jätkusuutlikkuse suunas, ei ole reaalset toodet (so rõivast) koos teiste süsteemi elementidega parendatud. See ebakõla näitab, et moe jätkusuutlikkuse edendamine ei toimu terviklikult, vaid osade kaupa. See lõputöö tahab seda olulist vajakajäämist adresseerida, asetades rõiva enese süsteemi keskpunktiks, täpsemalt sobivuse tehnilisest-metodoloogilisest vaatenurgast (so kui hästi riideese vastavale kandjale selga sobib), et kujundada moe jätkusuutlikkuse mudelid terviklikumateks.

Erinevad valdkonna sidusrühmad – nt rõivatootjad, kaubamärgid ja disainerid, jaemüüjad ja turustajad, tarbijad, hooldusteenused ning kogumise ja sorteerimise pakkujad – näevad jätkusuutlikkuse küsimust eri vaatenurkade alt, ning praegune moesüsteem ei innusta läbipaistvust ega koostööd. Toode (so rõivas) esindab süsteemi kesket osist, käitudes ühisosana kõigi osapoolte vahel. Siiski ei nähta vaatamata sellele juba toodetud ja turustatud rõivast potentsiaalse jätkusuutlikkuse võtmesõnana. Käesolev lõputöö keskendub just rõivale ning uurib süsteemi toote vaatekohalt, jälgides selle teekonda.

Täpsemalt ei peeta küsimusi, mis riide äraviskamist mõjutab (so miks klient vastavast tootest loobub) – jätkusuutlikkuse arutelu kuigi oluliseks aspektiks. Seega tuleb rõiva tajutud väärtus, füüsiline vastupidavus ning ebasobivuse üksikasjad mõtestada jätkusuutlikkuse olulisteks aspektideks. See lõputöö uurib üksikasjalikult rõiva sobivuse fenomeni ühe põhilise probleemina, mis rõivaste äraviskamist süvendab, ja see omakorda mõjutab olulisel määral moe jätkusuutlikkust. Rõiva istuvuse probleemide ja ära viskamise põhjused tulenevad halvasti sobituvate riiete tootmisest, standardiseeritud kehakujudest ja -mõõtudest ning tarbija kehaehituse muutumisest. Rõivaste istuvuse probleem on eriti tajutav mitme kasutajaga rõivaste propageerimise

juures. Siinkohal kasutaja vaheldumine ja kandja keha mõõtmete muutumine mängib olulist rolli ja võib olla rõiva pikaealisuse ja tsüklilisus vaatekohast kriitilise kaaluga.

Siinses uurimuses töötatakse välja istuvuse kohandamise mehhanism, mida osalejate seljas katsetatakse. Juhtumiuuringuks on võetud püksid, sest need esindavad moetööstuses istuvuse aspekti silmas pidades eriti keerulist toodet. Lisaks uuritakse töös pükste istuvusmehhanismi potentsiaalse lahendusena rõivajäätmete vähendamisel kogu süsteemi ulatuses, võimaldades ühekordse kasutajaga rõivastele pikemat eluiga ja suurendades mitme kasutajaga rõivaste taaskasutuspotentsiaali koos parema tarbijakogemusega.

See uurimistöö vaatleb kohandatava istuvuse kontsruktsioonimehhanismi *Uuse*, et näidata rõivaste kohandatavuse eeliseid ning parendada süsteemi. Selleks, et süsteem kohaneks istuvust muutvate rõivaste kontseptsiooniga peavad kogumis- ja ümberjagamis keskused ning seotud teenused arenema, toetudes rõivaste hooldusele ja parandusele. Lisaks tuleks kaubamärkidel pakkuda alternatiivseid müügimudeleid (rentimine, liisimine, taasmüük) igapäevase osana nende ärimudelitest. Viimaks tuleks tutvustada tagasisideahelat, et koondada ja edastada ümberjaotatud rõivastelt kogutud andmeid rõivaste loomise protsessidesse ja nende vahel.

Siinne lõputöö rõhutab rõiva istuvuse väheuuritud valdkonna potentsiaalset väärtust, et edendada jätkusuutlikke ärimudeleid ja tarbimistsükleid. Kuigi selle töö tulemused nõuavad edasiarendust, on neil uurimuse hinnangul märkimisväärne potentsiaal. Kohandatavad rõivad võivad muuta tarbija rõivataju (kuidas näevad tarbijad rõiva väärtust ja kasulikkust) ja seda, kuidas moega seotud ärid süsteemi panustavad. Uurimus pakub kaubamärkidele süsteemset muudatust, et loobuda pelgalt rõivatootmisest ja arendada ärimudelid rõivateekonna igaks astmeks, toetades seega rõiva eluea iga aspekti: loomist, turustamist, tarbimist ja rõiva hooldamist. *Uuse* on rõivaste arenduskontseptsioon, mille eesmärk on luua kohandatava istuvusega rõivaid, mis sobivad tarbijate kehakuju ning moesüsteemiga.

BIBLIOGRAPHY

Aldrich, W., 2008. Metric Pattern Cutting for Women's Wear. 5th Edition ed. Oxford: Blackwell Publisher.

Allfreesewing.com, n.d. *Letting-Out-Pants-new1_Large600_ID-3615650* [Image]. Available at: https://www.joom.com/en/products/5fabb2697a19f20106302610 [Accessed 15 04 2022].

Alto, M. & Palmer, P., 2003. Pants for Real People: Fit and Sew for Any Body. 2nd Edition ed. Portland: Palmer/pletch Incorpoarated.

American Society for Quality, n.d. Quality Glossary. [Online] Available at: https://asq.org/quality-resources/quality-glossary/q [Accessed 13 01 2022].

Anastas, P. T. & Zimmerman, J. B., 2003. Peer Reviewed: Design Through the 12 Principles of Green Engineering. Environmental Science & Technology, 23(5), pp. 94A-101A.

Armstrong, C. M., 2018. Product-Service System Design Thinking for Sustainable Fashion. In: K. Niinimäki, ed. Sustainable Fashion in a Circular Economy. Espoo: Aalto ARTS Books, pp. 102-109.

Bras-Klapwijk, R. M. & Knot, M. C., 2001. Strategic environmental assessment for sustainable households in 2050: Illustrated for clothing. Sustainable Development, Volume 9, pp. 109-118.

Braungart, M. & McDonought, W., 2009. Cradle to Cradle: re-making the way we make things. London: Vintage Books.

Bubonia, J. E., 2014. Apparel quality: a guide to evaluating sewn products. New York: Bloomsbury Publishing Inc.

Burns, B., 2010. Re-evaluating obsolescence and planning for it. In: Longer Lasting Products. Surrey: Gower.

Camargo, L. R., Pereira, S. C. F. & Scarpin, M. R. S., 2019. Fast and ultra-fast fashion supply chain management: an exploratory research. International Journal of Retail & Distribution Management, 48(6).

Chapman, J., 2005. Emotionally Durable Design: Objects, Experiences and Empathy. London: Earthscan.

circular.fashion, 2018. CIRCULAR DESIGN KIT Design strategies for material cyclability and longevity,

Cooper, T., 2005. Slower Consumption: Reflections on Product Life Spans and the "Throwaway Society". Journal of Industrial Ecology, 9(Number 1-2), pp. 51-67.

Creswell, J. W., 2003. Research design: qualitative, quantitative, and mixed method approaches. 4th Edition ed. Thousand Oaks: SAGE.

Crobsy, P. B., 1979. Quality is Free. New York: McGraw-Hill.

Dead White Man's Clothes. 2021. [Film] Directed by Liz Ricketts.

Dunham, G. R., 2021. The Fitting Book: Make Sewing Pattern Alterations and Achieve
the Perfect Fit You Desire. Gina Renee Designs.

Duong, T., 2021. Chile's Atacama Desert: Where Fast Fashion Goes to Die. [Online]
Available at: https://www.ecowatch.com/chile-desert-fastfashion-
2655551898.html [Accessed 30 March 2022].

Durrani, M., Niinimäki, K. & McLauchlan, S., 2021. Designing for and with Garment
Repair: an Exploration of Future Possibilities. In: N. Nissen & M. Jaeger-Erben,
eds. PLATE Product Lifetimes And The Environment 2019 - Conference
Proceedings. Berlin: TU Berlin University Press, pp. 227-231.

Earley, R. & Goldsworthy, K., 2015. Designing for fast and slow circular fashion
systems: exploring strategies for multiple and extended product cycles. Prod
Lifetimes And The Environment, Volume 2, pp. 1-7.

Ellen MacArthur Foundation, 2013. Towards the circular economy: Economic and
business rationale for an accelerated transition, Ellen MacArthur Foundation.

Ellen MacArthur Foundation, 2013. Towards the circular economy: Opportunities for the
consumer goods sector, : Ellen MacArthur Foundation.

Ellen MacArthur Foundation, 2017. A new textiles economy: redesigning fashion's
future.

Ellen MacArthur Foundation, 2021. Circular business models: Redefining growth for a
thriving fashion industry.

Ellen MacArthur Foundation, 2021. Circular Design for Fashion. Oxford: Ellen MacArthur
Foundation Publishing.

Ertz, M., Leblanc-Proulx, S., Sarigöllü, E. & Morin, V., 2019. Made to break? A
taxonomy of business models on product lifetime extension. Journal of Cleaner
Production, Volume 234, pp. 867-880.

European Commission, 2022. EU Strategy for Sustainable and Circular Textiles. [Online]
Available at: https://eur-lex.europa.eu/legal-
content/EN/TXT/?uri=CELEX%3A52022DC0141 [Accessed 15 April 2022].

Fashion Revolution, 2020. Fashion Transparency Index 2020,

Fashion Revolution, 2021. Fashion Transparency Index 2021,

Fashionscapes: A Circular Economy. 2021. [Film] Directed by Andrew Morgan.

Fletcher, K., 2008. Sustainable Fashion and Textiles. Design Journeys. London:
Earthscan.

Fletcher, K., 2010. Slow fashion: an invitation for system change. Fashion Practice: The
Journal of Design, Creative Process & the Fashion, Issue 2, pp. 259-266.

Fletcher, K., 2012. Durability, Fashion, Sustainability: The Processes and Practices of Use. Fashion Practice, 4(2), pp. 221-238.

Flick, U., 2006. An Introduction to Qualitative Research. 3rd ed. Thousand Oaks: Sage .

Gardetti, M. A., 2019. Introduction and the concept of the circular economy. In: Circular economy in textiles and apparel : processing, manufacturing, and design. Oxford: Woodhead Publishing.

Glitsch, V. S., 2020. Fit step in ready-to-wear clothing. Towards a reduction of garment disposal in view of sustainability. Doctoral thesis, Rauland: University of South-Eastern Norway.

Goldsworthy , K., 2014. Design for Cyclability: Pro-active approaches for maximising material recovery. Making Futures Journal, Volume 3, pp. 2042-1664.

Goldsworthy, K., Earley, R. & Politowich, K., 2018. Circular Speeds: A Review of Fast & Slow Sustainable Design Approaches for Fashion & Textile Applications. Journal of Textile Design Research and Practice, Volume 6:1, pp. 42-65.

Gopalakrishnan, D., Srikrishnan, M. R. & Kanhavadivo, P., 2017. The rise of sustainability in textile manufacturing life cycle. In: M. Parthiban, M. R. Srikrishnan & P. Kanhavadivu, eds. Sustainability in Fashion and Apparels: Challanges and Solutions. New Delhi: Woodhead Publishing India, pp. 55-72.

Gwilt, A. & Pal, R., 2017. Conditional garment design for longevity. PLATE: Product Lifetimes And The Environment, Volume 9, p. 149–153.

Gwilt, A., 2021. Caring for clothes: how and why people maintain garments in regular use. Continuum, 35(6), pp. 870-882.

Henninger, C. E., Bürklin, N. & Niinimäki, K., 2019. The clothes swapping phenomenon – when consumers become suppliers. Journal of Fashion Marketing and Management, 23(3), pp. 327-344.

Hirscher, A., Niinimäki, K. & Armstrong , A., 2018. Social manufacturing in the fashion sector: New value creation through alternative design strategies?. Journal of cleaner production, Volume 172, pp. 4544-4554.

Hvass, K. K., 2016. Weaving a Path from Waste to Value: Exploring Fashion Industry Business Models and the Circular Economy. PhD Series, No. 6.2016, Frederiksberg: Copenhagen Business School (CBS).

Joom.com, n.d. Trousers waist adjustment button [Image]. Available at: https://www.allfreesewing.com/Bottoms-to-Sew/Letting-Out-Pants [Accessed 15 04 2022].

Juran, J. M., 1999. Juran's quality handbook. New York: McGraw Hill.

Kassatly, V. B. & Baumann-Pauly, D., 2022. The Great Greenwashing Machine, Part 2, Eco-Age.

Khundi, J, n.d. *How to add adjustable elastic to kids' pants in 5 easy steps* [Image]. Available at: https://kundhi.com/blog/2009/11/24/how-to-add-adjustable-elastic-to-kids-pants-in-5-easy-steps/ [Accessed 15 04 2022].

Kirchherr, J., Reike, D. & Hekkert, M., 2017. Conceptualizing the circular economy: an analysis of 114 definitions. Resources, Conservation and Recycling, Volume 127, pp. 221-232.

Klepp, I. G. et al., 2022. Discussion paper – Accounting for Non-Physical Durability,

Laitala, K. & Klepp, G., 2020. What Affects Garment Lifespans? International Clothing Practices Based on a Wardrobe Survey in China, Germany, Japan, the UK, and the USA. Sustainability, 12(21).

Laitala, K. & Klepp, G., 2021. Clothing Longevity: The Relationship Between The Number of Users, How Long and How Many Times Garments are Used. Limerick, 4th PLATE 2021 Virtual Conference.

Laitala, K. & Klepp, I. G., 2011. Environmental improvement by prolonging clothing use period,

Lim, H.-W. & Cassidy, T., 2017. A comparative study of trousers pattern making methods. Journal of Textile Engineering & Fashion Technology, Issue 1 (5), pp. 189-196.

McDonough, W. & Braungart, M., 2002. Cradle to cradle: remaking the way we make things. New York: North Point Press.

McDonough, W. & Braungart, M., 2013. The Upcycle: Beyond Sustainability--Designing for Abundance. Farrar: Straus and Giroux.

Meadows, D., 1999. Leverage points: Places to intervene in a system, Hartland: The Sustainability Institute.

Meiko Tailor, 2021. Trousers with side adjusters [Image]. Available at: https://www.meikotailor.com/post/belt-loops-vs-side-adjusters-which-do-you-choose [Accessed 15 04 2022].

Niinimäki, K. & Armstrong, C., 2013. From Pleasure in Use to Prevention of Meaningful Memories: A Closer Look on Sustainability of Clothing via Longevity and Attachment. International Journal of Fashion Design, Technology and Education, 6(3), pp. 190-199.

Niinimäki, K. et al., 2020. The environmental price of fast fashion. Nat Rev Earth Environ, Volume 1, p. 189–200.

Niinimäki, K., 2011. From Disposable to Sustainable: the Complex Interplay between Design and Consumption of Textiles and Clothing. Helsinki: Aalto University publication series DOCTORAL DISSERTATIONS.

Niinimäki, K., 2018. Sustainable Fashion in a Circular Economy. In: K. Niinimäki, ed. Sustainable Fashion in a Circular Economy. Espoo: Aalto ARTS Books, pp. 12-41.

Park, J., Sarkis, J. & Wu, Z., 2010. Creating integrated business and environmental value within the context of China's circular economy and ecological modernization. Journal of Cleaner Production, 18(15), pp. 1494-1501.

Piippoo, R., Niinimäki, K. & Aakko, M., 2022. Fit for the Future: Garment Quality and Product Lifetimes in a CE Context. Sustainability, Volume 14,726, p. https://doi.org/10.3390/su14020726.

Piscicelli, L., Cooper, T. & Fisher, T., 2015. The role of values in collaborative consumption: insights from a product-service system for lending and borrowing in the UK. Journal of Cleaner Production, Volume 97, pp. 21-29.

S. Yang, N. F., 2008. Case study of industrial symbiosis: nanning sugar Co., ltd. in China. Resources, Conservation and Recycling, 52(5), pp. 813-820.

Sinha, P., Muthu, S. S. & Dissanayake, G., 2016. Remanufactured Fashion. Singapore: Springer.

Smith, P. B., 1979. Making Your Clothes Fit: A Step-by-Step Illustrated Guide to Custom Fitting Home-Sewn and Ready-to-Wear Clothing. New York: Knopf Doubleday Publishing Group.

Stahel, W. R., 2016. Circular economy. Nature, Volume 531, p. 435–438.

Standard, 2017. EN 13402-3:2017 Size designation of clothes - Part 3: Size labelling based on body measurements and intervals,

Sterman, J., 2013. 5 ways 'systems thinking' can jumpstart action. [Online] Available at: https://www.greenbiz.com/article/5-ways-systems-thinking-can-jumpstart-action [Accessed 1 February 2021].

The New Standard Institute, 2021. The New York State Senate. [Online] Available at: https://www.nysenate.gov/legislation/bills/2021/A8352 [Accessed 10 01 2022].

The New Standard Institute, n.d. [Online] Available at: https://www.newstandardinstitute.org/communitymain [Accessed 10 01 2022].

Tukker, A. & Tischner, U., 2006. Product-services as a research field: past, present and future. Reflections from a decade of research. Journal of Cleaner Production, 14(17), pp. 1552-1556.

Webster, K., 2017. The circular economy. A wealth of flows.. 2nd edition ed. Cowes: Ellen MacArthur Foundation.

Weinswig, D., 2017. Fast fashion speeding toward ultrafast fashion. [Online] Available at: https://coresight.com/research/fast-fashion-speeding-toward-ultrafast-fashion/ [Accessed 2 11 2021].

WRAP, 2012. Valuing our Clothes: the Evidence Base. Technical Report.

WRAP, 2016. Recycling Tracking Survey 2016 Behaviours, attitudes and awareness around recycling, Banbury: Prepared by WRAP.

WRAP, 2017. Valuing Our Clothes: the cost of UK fashion, Technical Report.

WRAP, 2020. Clothing and Behavioural Insights During Covid-19 Restrictions, Banbury: WRAP.

LIST OF FIGURES

APPENDICES

Appendix 1 Interview guide

Interviews with professionals in the garment industry

Sustainable Factory
- Interview topics:
- Sustainable factory ideology and working processes
- Where the fashion industry is going and what could be the future for more sustainable design-development/manufacturing.
- Brand and factory relationships
- Sustainability in Elongating product use time
- Role of factories in the future of manufacturing
- The meaning of sustainability for factory
- What is your company advantages in the market?
- What are the biggest challenges in setting up sustainable factory?
- Local manufacturing
- Circularity

Factories Estonia
- Üldinfo - konkurents
- Mis on Teie firma eesmärk?
- Mis on teie eelised turul?
- Kuidas hoiate end turul konkurentsis.
- Mis on teie suurimad väljakutsed, kuidas jääda konkurentsivõimeliseks?
- Paljud eesti tehased on lõpetanud töö Eestis ja kolinud oma tootmise välismaale, mis on taganud teie ellujäämise Eestis.
- Kliendid
- Kes ja kui suured on teie kliendid. Eesti/välismaa.
- Mis võimalusi pakute oma klientidele. Toodang / tooteplaneerimine / tootearendus
- Mis on suurimad raskused klientidega tootearengu faasis
- Kui palju teie toetate tootearengut, kuidas suunate
- Kas kasutate ka tehnoloogiat, 3d näidised jne
- Jätkusuutlikkus
- Kuidas te kirjeldaksite, mis on jätkusuutlik toodang.

- Kas teil on plaanis, või on juba kasutusel loodussõbralikumaid tootmisviise.
- Kas on ka kliente, kes sellele väga rõhuvad.
- Kuidas jääte keskkonnasektori viimastest arengutest ettepoole?
- Mis on põhilised takistused uute tehnoloogiate kasutamisel
- Kvaliteet
- Kas teie kvaliteeti standardid on pandud paika teie poolt või klient määrab need.
- Kuidas te tagate toodete jätkusuutlikkuse.
- Kui kujutate teie toodete elutsüklit (hällist hauani), siis kas saate selles kirjeldada peamisi sidusrühmi, kellel on teie tehase jätkusuutlikkuse saavutamisel suur roll?

Brands
- Üldinfo - konkurents
- Mis on teie eelised turul?
- Kuidas hoiate end turul konkurentsis.
- Mis on teie suurimad väljakutsed, kuidas jääda konkurentsivõimeliseks?
- Kas kaaluksite oma tootmise Eestist välja viimist
- Kliendid
- Kes ja kui suured on teie tehased
- Mis võimalusi nad pakuvad. Toodang / tooteplaneerimine / tootearendus
- Mis on suurimad raskused tehastega tootearengu faasis
- Kui palju tehased tootearengut.
- Kas kasutate ka tehnoloogiat, 3d näidised jne
- Jätkusuutlikkus
- Kuidas te kirjeldaksite, mis on jätkusuutlik toodang.
- Kas teil on plaanis, või on juba kasutusel loodussõbralikumaid tootmisviise.
- Kas on ka kliente, kes sellele väga rõhuvad.
- Kuidas jääte keskkonnasektori viimastest arengutest ettepoole?
- Mis on põhilised takistused uute tehnoloogiate kasutamisel
- Mis teete järelejäänud toodetega
- Kvaliteet
- Kas teie kvaliteeti standardid on pandud paika teie poolt või tehas määrab need.
- Kuidas te tagate toodete jätkusuutlikkuse.
- Kui kujutate teie toodete elutsüklit (hällist hauani), siis kas saate selles kirjeldada peamisi sidusrühmi, kellel on teie tehase jätkusuutlikkuse saavutamisel suur roll?

Sustainability consultant
- The role of factories in sustainability
- Aspects what brand and factory look for when working with sustainability
- Design and manufacturing solutions for sustainability

- Collaboration in the fashion industry between stakeholders
- How it would be possible to create a truly quality and sustainable garments (which will last for many lifecycles – to be suitable for reselling, renting, redesigning, remanufacturing).

Garment technologist
- The role of factories in sustainability
- Aspects what brand and factory look for when working with sustainability
- Design and manufacturing solutions for sustainability
- Collaboration in the fashion industry between stakeholders
- How it would be possible to create a truly quality and sustainable garments (which will last for many lifecycles – to be suitable for reselling, renting, redesigning, remanufacturing).

Repair
- Background
- Experience
- Clients
- Benefits of repair
- Common repair / alteration jobs
- Clients' relationship with their clothes
- What makes repair difficult sometimes (how garments constructed, designed, fabrics used etc, etc)
- Is it possible to make garment bigger?
- What are the restraints of garments when it comes to repair and alterations?
- What makes repair difficult sometimes (how garments constructed, designed, fabrics used etc, etc)
- The condition / quality of repaired garments
- What type of garments (t-shirts, vintage, luxury)?
- Change over the years – how the new trends are affecting types of repairs asked
- Clients' relationship to the garment
- Stories because they need to get stuff fixed

Appendix 2 Common trousers fit issues

| Waist too tight | Crotch too high and tight | Crotch too high | Crotch too tight | Crotch curve too shallow | Too tight at thigh | Too tight at thigh | | Too tight at hip | | Seat too tight |

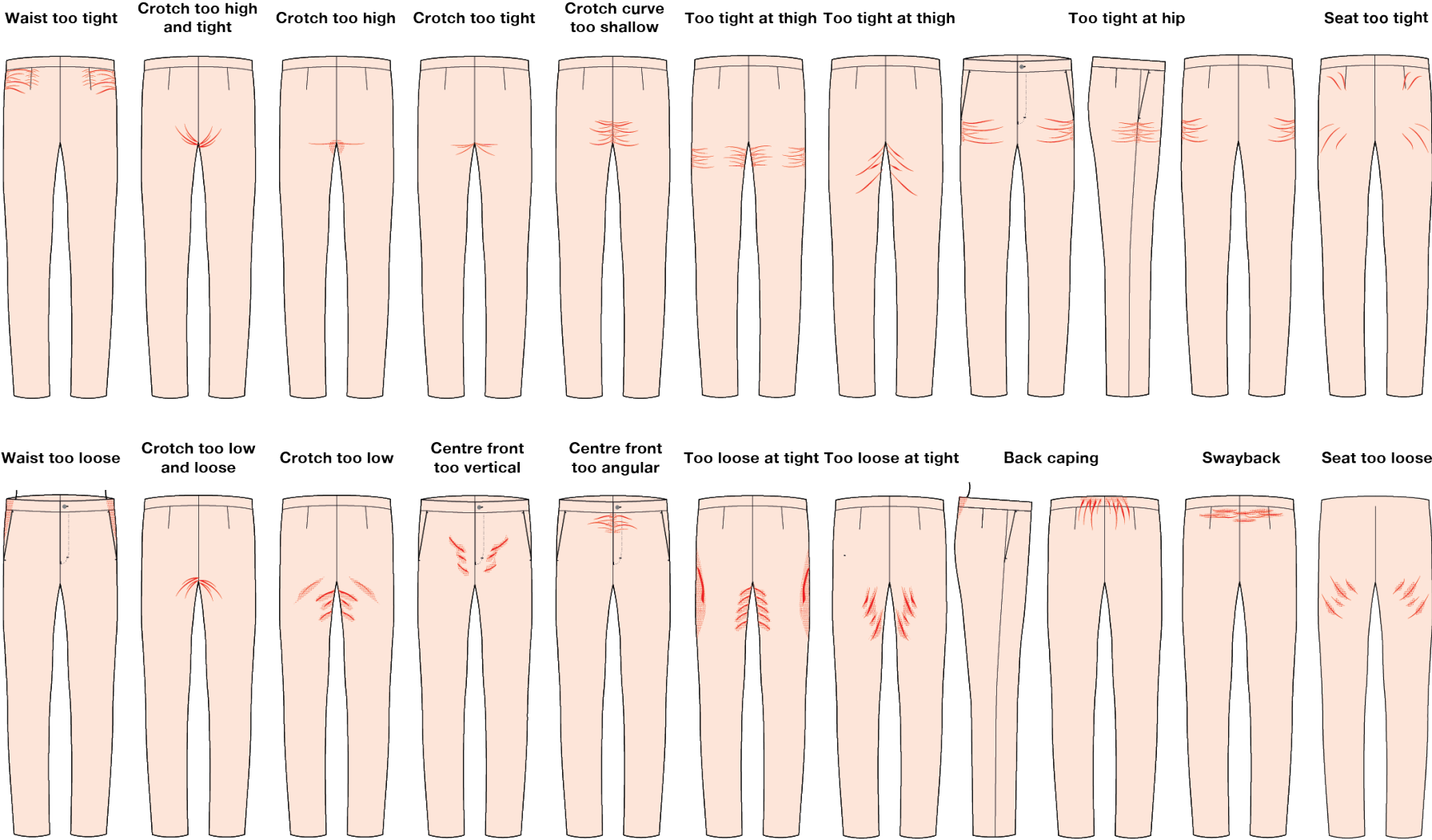| Waist too loose | Crotch too low and loose | Crotch too low | Centre front too vertical | Centre front too angular | Too loose at tight | Too loose at tight | | Back caping | Swayback | Seat too loose |

Figure A-2 Common trousers fit issues – Tiina Ree based on (Alto & Palmer, 2003; Dunham, 2021; Aldrich, 2008; Smith, 1979)

Appendix 3 Fitting Experiment

Figure A-3 Trousers fitting experiment fit adjustments for ill-fitting trousers 1-4 Figure A-4

Figure A-3.1Trousers fitting experiment fit adjustments for ill-fitting trousers 5-8

Appendix 4 Prototype testing

	A	B	C	D	E
waist	76	75	82	80	90
hip	95	101	97	93	103
thigh	56	59	57	55	57
inside leg	75	73	71	70	78

Figure A-4 UUSE Garment journey and points of benefits.