

MSc Graduation Thesis Rychon Tokromo

Demystifying TOG Care in Collaboration with Bever



January 2025

Delft University of Technology

Landbergstraat 15
2628CE Delft
The Netherlands

Graduate Student

Rychon Tokromo

MSc Student Integrated Product Design
TU Delft, Industrial Design Engineering

Supervisors

Lise Magnier

Associate Professor of Design for Sustainable Behaviour Change
TU Delft, Industrial Design Engineering

Stefano Parisi

Professor of Sustainable Design Engineering
TU Delft, Industrial Design Engineering

Marjolein Vendrig

Head of Marketing
Bever



Preface

My name is Rychon Tokromo, and I am a product designer and a Hip-Hop fanatic.

During my teenage years, my interest in Hip-Hop music started growing. Parallel to that interest, my affinity for sneakers and fashion also grew. As I matured, my fashion fanaticism did as well, and I became more aware of the effects of the fashion industry on our environment. Initially, I wanted to study at IDE because I wanted to design sneakers or clothing, but my newfound awareness of the industry’s pollution pivoted my ambition in a different direction: I wanted to explore how we could incorporate sustainability in fashion.

These ideas led to my first project proposal, which was about making consumer repair of garments more accessible. After countless emails and rejections I finally came in contact with Bever about a similar subject:

“How can we demystify the process of maintaining technical outdoor garments for Bever’s consumers? “

After the official agreements were made, I was excited and intrigued to work on this project. I am happy to have worked on an issue that aligned with my ambitions and affinities for these past six months, and I am excited to show you what I have worked on.

Acknowledgments

To my supervisors: Lise & Stefano

When I started the project, I was scared of having the same negative experiences as some of my peers had with their supervisors. Fortunately this was not the case, I thoroughly enjoyed our collaboration. Meetings were both enjoyable and productive, and unexpected replies to my emails on your off-days left me stunned. Thank you for providing your expertise, feedback, and overall support during my thesis.

To my colleagues at Bever

I would like to thank my colleagues Marjolein and Christian for giving me a chance to tackle this interesting subject and problem to finish my Master’s with. Thanks to the colleagues at the office people for showing me around on my first day, providing feedback, and showing interest in my thesis. I would also like to thank my colleagues in the Bever stores for their helpfulness when I was conducting my tests.

To my parents: Amir & Inah Tokromo

As first-generation immigrants, I admire you for sacrificing so much to provide me with the means and motivation to achieve a higher education. I have no idea how I could ever pay you back. Perhaps this thesis is a first step to achieve that. Without your support I would have never made it this far, thanks mom and dad.

To my girlfriend: Sanne

Thank you for your motivation when mine bled out. For lending me your ears when I needed a second opinion, your unconditional support, and always being there for me.

Abstract

This master’s thesis investigates how to improve product care practices for Technical Outdoor Garments (TOG) among consumers. Working with Bever, the Netherlands’ leading outdoor retailer, the research examines ways to extend product lifespans through better maintenance. The study identifies key barriers preventing proper TOG care and develops The Buitenmens Sherpa, a solution to make TOG care more accessible and routine.

The thesis provides a comprehensive overview of TOG, including waterproof, down-filled, and synthetic-fill garments, as well as the importance of Durable Water Repellent (DWR) treatments. It examines current product care practices, the role of care labels, and the specific washing and drying requirements for TOG. The research utilizes the Fogg Behavior Model to analyze consumer behavior regarding product care and explores related work in the field of sustainable consumption..

By examining Bever’s sustainability initiatives, consumer behavior patterns, and circular economy principles, this thesis proposes a notification system that reminds users when TOG need care and makes the maintenance process more accessible. This solution aims to maximize garment longevity, minimize environmental impact, and advance circular economy practices in outdoor apparel.

Glossary

TOG (Technical Outdoor Garments)

Specialized clothing designed for outdoor activities, featuring engineered textiles and materials that provide weather protection, including waterproofing, insulation, and breathability.

DWR (Durable Water Repellent)

A coating applied to outdoor garments that causes water to bead up and roll off the fabric surface, maintaining breathability while providing water resistance.

Circular Economy

An economic system aimed at eliminating waste by continuously reusing and recycling resources, extending product lifespans, and minimizing environmental impact.

Buitenmens

Dutch term meaning “Outdoor Human,” referring to Bever’s own product collection made from recycled materials.

Second Chance

Bever’s program for upcycled or repaired clothing that has been restored for resale.

FBM (Fogg Behavior Model)

A framework for understanding human behaviour change that considers three elements: motivation, ability, and triggers.

Introduction

Bever’s first establishment was opened in 1977, in The Hague, by nature photographer Fred van Olphen. Bever was initially created as a place where one could easily find every essential to indulge in the outdoors, after van Olphen experienced that finding these products and materials proved to be difficult when preparing for a canoe expedition across the Yukon river.

Since the Bever’s genesis in 1977, it has now expanded to the biggest outdoor gear store of the Netherlands with more than 40 stores, an expansive web shop, and more than 1000 employees all across the Netherlands. Due to Bever’s identity being rooted in the outdoors, it is an organization that feels responsible for the environment. Their commitment to sustainability is apparent through the various provided services, and incentives they are currently employing within the company.

Bever offers a diverse range of outdoor products from both major and small brands. While their inventory includes camping and mountaineering equipment, their technical outdoor garments (TOG) are particularly notable.

These specialized garments provide weather protection that allows outdoor enthusiasts to safely enjoy their activities in various conditions. The garments are constructed with engineered textiles and materials that create protective properties, such as waterproofing, water repellency, water resistance, insulation, and breathability. This makes them distinct from regular

clothing and also require specific care to maintain their performance. Unfortunately, consumers appear to face barriers in the maintenance process, according to research done by Bever (Bever, 2024), which could lead to improper or neglected care. This is not surprising, since other studies have noted that people struggle with maintaining or repairing their products (Ackermann et al., 2018; J. Corn, 2011).

Product care is linked to increasing product longevity (Jensen, 2023). Through educating consumers about proper care and encouraging them to extend product lifespans, they can maximize value retention. This results in reducing waste and minimize the need for product replacements, benefiting the environment in the long run. This thesis explores a solution to address Bever’s maintenance challenges while aligning with their “responsible for the outdoors” identity and potentially creating a competitive advantage in the outdoor retail market.

We came in contact about this issue through Marjolein Vendrig (Marketing Director) and Christian de Jong (Sustainability and Services Director). Together with them, we established the first iteration of the design problem that was the foundation of this thesis.

Design Problem

“To ensure that consumers can enjoy their technical garments as long as possible, efforts must be made to find a solution that alerts consumers when their technical outdoor garments need product care and simplifies this often unfamiliar process.”

Design Methodology

For the overall approach of this design project, we used a Triple-Diamond method. In comparison to the familiar Double-Diamond that has been handled in previous courses of the TU Delft's IDE curriculum, this method that has an additional phase.

We chose to follow the Triple-Diamond method because we had positive experiences, and familiarity with the Double-Diamond method during our academic career. The converging and diverging in each phase inspired our first planning, and made a project of this scale more digestible.

In our Triple-Diamond we established three phases: Researching & Analyzing, Conceptualizing Solutions, and Development & Evaluation. At the end of each phase we envisioned a concrete goal essential for the continuation of the following phase. A complete overview of our Triple-Diamond is displayed in figure 1.

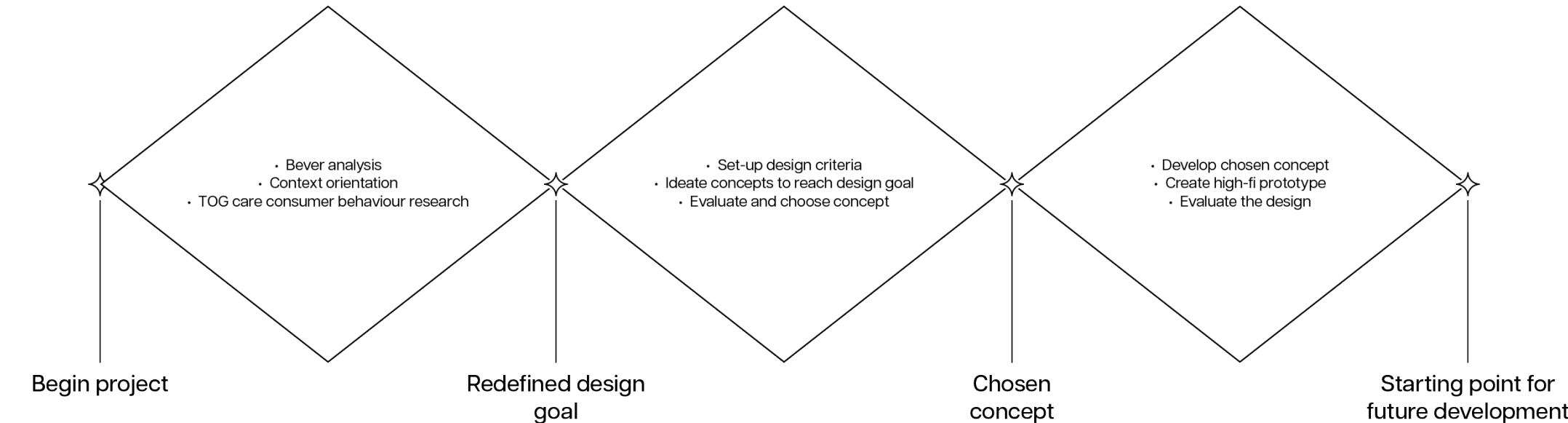
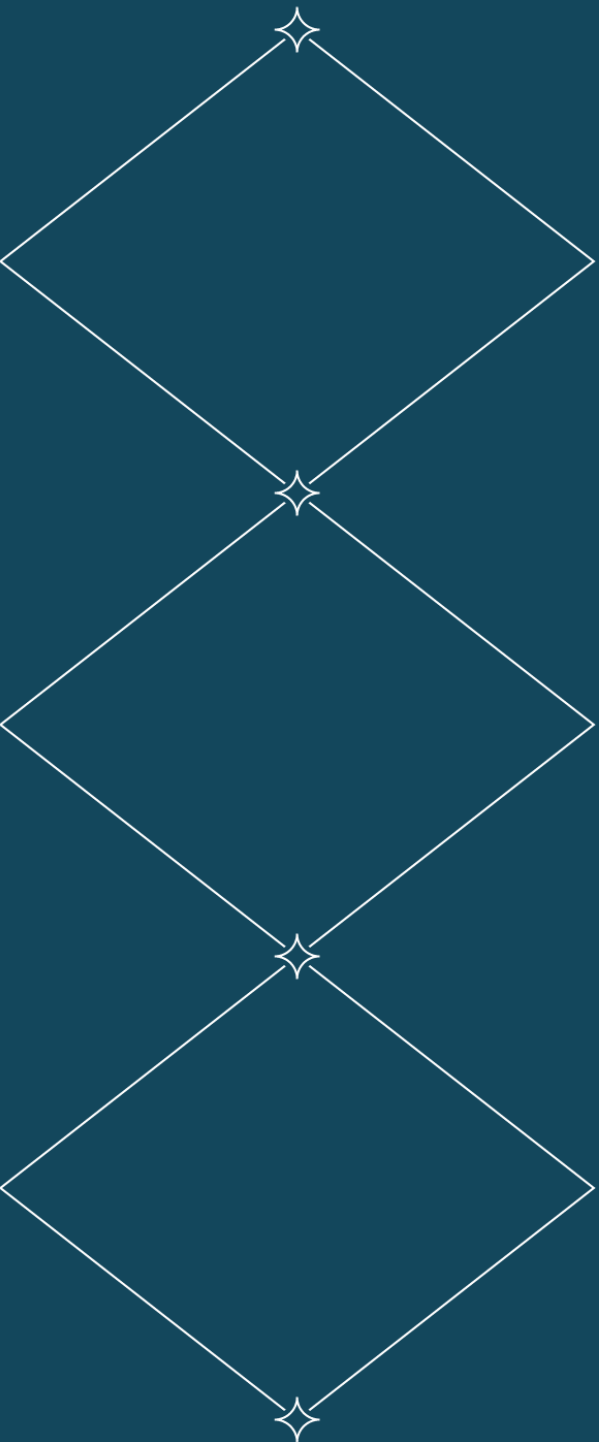


Figure 1. Triple Diamond Method

Phase 1: Researching & Analyzing

This phase aimed to develop a comprehensive understanding of our project's context and problem. There were three main parts of this phase:

1. Bever analysis → Through conversations with Bever employees, online information about Bever, internal data, and Bever's own research, we gained a better understanding of Bever as an organization.
2. Context orientation → Found research papers about consumer behaviour and the circular economy. Also collected information about technical outdoor garments.
3. TOG care consumer behaviour investigation → Based on the previous two parts, we created a survey to investigate TOG care of Bever consumers.

The milestone of this phase was to define a more focused design goal to continue with in the next phase.

Phase 2: Conceptualizing Solutions

The conceptualization phase was meant to explore different ideas and concepts that could help us achieve our design goal:

1. Set-up design criteria → We formulated design criteria according to our research.
2. Ideate concepts to reach design goal → We created concepts through sketching and brainstorming.
3. Evaluate concepts and choose definitive concept → Evaluated and chose a definitive concept, based on our design criteria

The milestone of this phase was to have a concept that could be developed and evaluated in the final phase

Phase 3: Development & Evaluation

This phase aimed at developing and refining the chosen concept into a viable design with a high fidelity prototype that could be tested with users.

1. Develop chosen concept → We made improvements to our concept and developed it to a more comprehensive design.
2. Create high fidelity prototypes → By creating a high fidelity prototype, we were able to evaluate parts of our design with the intended users.
3. Conclude design process → Draw conclusions according to how we framed the project. List all recommendations for future development of the design.

The milestone of this phase was to finish the project with a design that was evaluated with users and provides insights and recommendations for future development of this design by Bever.

Table of Contents

Phase 1: Researching & Analyzing

1. Bever in-depth analysis	12
1.1. Bever HQ	12
1.2. Bever Stores	13
1.3. Bever's Identity	14
1.3.1. Best Product	14
1.3.2. Best Inspiration	14
1.3.3. Best Inspiration	14
1.3.4. Best Inspiration	15
1.3.5. A gap for our project	15
1.4. Bever's Target Audience	16
1.5. Characteristics from Bever Data	16
1.5.1. Mentality	16
1.5.2. Income	16
1.5.3. Age	16
1.6. Key Takeaways	17
2. Theoretical Foundations of the Circular Economy	18
2.1. The Butterfly Diagram	19
2.2. The Evolution of the Circular Economy	20
2.2.1. Implications for Our Context	21
2.3. Types of Maintenance	21
2.3.1. Implications for Our Context	21
2.4. Design for Ease of Maintenance and Repair	22
2.5. Key Takeaways	23
3. What Are Technical Outdoor Garments?	24
3.1. Waterproof Garments	25
3.2. Water Repellent/Resistant Garments	26
3.3. Down-fill Garments	27
3.4. Synthetic-fill Garments	28
3.5. Durable Water Repellent (DWR)	29
3.5.1. DWR Controversy	29
3.6. TOG Overview	30
4. What is Product Care?	31
4.1. Washing & Drying	32
4.2. DWR Restoration	32
4.3. Care Labels	33
4.4. Product Care Instructions per TOG	34
5. Consumer Behaviour Background and Industry Insights	36
5.1. The Fogg Behaviour Model	37
5.1.1. Motivation	37
5.1.2. Ability	37
5.1.3. Triggers	37
5.2. The Fogg Behaviour Model Applied to Product Care	38
5.2.1. Care Motivators	38
5.2.2. Care Ability Factors	38
5.2.3. Care Triggers	38
5.3. Bever's Previous Research	39
5.4. Bever's Previous Research	40
5.5. Key Takeaways	41

6. Investigating Product Care through the Fogg Behaviour Model	42
6.1. Pilot Study	43
6.1.1. Goal	43
6.1.2. Results	43
6.1.3. Direction for Definitive Survey	43
6.2. Methodology	44
6.2.1. Research Design	44
6.2.2. Sampling Technique and Sample Size Determination	44
6.2.3. Data Analysis Techniques	44
6.3. Results	45
6.3.1. General Descriptive Statistics	45
6.3.2. FBM Factor Analysis	46
6.3.3. Correlation Analysis	48
6.4. Result Summary	49
6.4.1. Product Care Participation	49
6.4.2. Product Care Behaviour	49
6.4.3. Owned TOG Types	49
6.4.4. FBM Factors	49
6.4.5. Correlation Analyses	49
6.5. Conclusion	50
6.6. Discussion	50

Phase 2: Conceptualizing Solutions

7. Ideation	51
7.1. Design Goal Redefinition	52
7.2. Action Points for Ideation	52
7.3. Ideation Process	52
7.4. Sketches to Concepts	54
7.5. Choosing Definitive Concept	55
7.6. Design Goal Redefinition after Bever's Feedback	56
7.7. Merging Concepts: Three Birds with One Stone	56
7.8. Limitations & Recommendations	56
7.9. The Buitenmens Sherpa Requirements	57
7.9.1. Research conclusion relevant criteria	57
7.9.2. Concept Component criteria	57
7.9.3. Bever Criteria	57
7.9.4. Circular Economy Criteria	57

Phase 3: Developing & Evaluating

8. Design Development	59
8.1. Design Inspirations	60
8.1.1. Inspirations for The Kit	60
8.1.2. Inspirations for The Care Mark	60
8.2. The Kit	61
8.2.1. Prototyping & Evolution of the Kit	62
8.2.2. Resource Cycle of the Kit	64
8.2.3. TOG Detergent & Wash-in Treatment	64
8.3. The Care Mark	65
8.4. Developing the Care Mark	66

8.4.1. What are Invisible Contaminants?	66
8.4.2. Halochromic Textiles	66
8.4.3. Animated Linen	66
8.4.4. Choosing A Reactive Textile	66
8.4.5. Exploring Halochromism	67
8.4.6. The Colour Change Cycle	68
8.4.7. Limitations of Anthocyanin Based Halochromic Pigments	69
8.5. The Booklet	70
8.6. The Buitenmens Sherpa as a PSS	73
8.6.1. Customer Journey	73
8.6.2. Backstage Processes	73
8.7. Design Validation	74
8.7.1. Validation Questions	74
8.7.2. Validation Test Setup	75
8.7.3. Validation Test Results	75
8.7.4. Cost estimation	75
8.7.5. Conclusions	77
8.7.6. Limitations	77
9. Project Discussion	78
9.1. Design Evolution	78
9.2. Design Evolution	78
9.3. Impact on Sustainable Consumer Behaviour	78
9.4. Care Mark's Effectiveness	78
9.5. Integration within Bever	78
9.6. Recommendations	78
10. Project Conclusion	79
11. Personal Reflection	80

Phase 1: Researching & Analyzing

1. Bever in-depth analysis

To gain a better understanding of the company that we are collaborating with during this research project, a thorough analysis was conducted of Bever's organizational structure, business operations, and company culture. This analysis includes insights gathered from interviews with key personnel, observations at their facilities, and examination of internal documents. Through this comprehensive investigation, we can better understand how Bever positions itself in the outdoor retail market and how its various operations support its sustainability goals.

1.1. Bever HQ

Bever's HQ is located in Pijnacker-Nootdorp, a municipality in the Zuid-Holland provenance. Their HQ consists of two buildings; One building is dedicated to the offices and the distribution center, the other building accommodates Bever's sustainability service center.

As the name suggests, the sustainability service center houses all sustainable services that Bever offers to their customers. This involves a sewing atelier where garments are repaired or up-cycled, a washing service specifically for Technical Outdoor Garments and other products made from technical textiles, and a shoe cleaner for specialty footwear such as hiking boots. Moreover, there also is a recycling collection center,

where products that can not be repaired, resold, or reused get categorized and sent to the appropriate recycling partners of Bever.

After a tour by Steffen Sporry, the Services & Guaranty Teamlead that oversees the operations at the center, he explained that Bever receives recycled material from some of the recycling partners. With this resource they create products for their 'Buitenmens' collection. Translated to 'Outdoor Human' from Dutch, Bever sells their own product in select stores. Bever also sells 'Second Chance' clothing, which is upcycled or repaired clothing that was discarded or was too damaged to return to their consumers.



1.2. Bever Stores

The sustainability vision also apparent in the design of Bever's stores. When we visited Bever's flagship store in the Mall of the Netherlands in Leidschendam, we noticed installations and amenities that affirm the dedication to being a sustainable retailer. Here is a summary of everything that we came across during our visit, and is similar to what can be found in most Bever stores across the Netherlands:

The store features a maintenance and repair center where customers can have their products repaired or cleaned,

purchase maintenance and repair supplies, and receive expert consultation about their products.

A collection bin is also present in stores. Customers can discard products here. These consequently get transported to the service center for donation partners. One of them is Sheltersuit: an organization that creates protective, multifunctional products from old textile for the homeless (Sheltersuit Foundation, n.d.). Products that are not sent to donation partners get re-purposed by Bever or one of their

recycling partners. For example, Sympany is a company that collects textile, and creates 'new' materials them (Sympany, 2024).

Lastly, there are various displays that promote Bever's sustainable services and vision. These include repaired clothing displayed to showcase the repair service, a presentation of Bever's Buitenmens collection, and posters with QR codes linking to digital media throughout the store.



Figure 2. In-store maintenance and repair center.



Figure 3. Collection bin



Figure 4. Promotional display

1.3. Bever’s Identity

After talking with several Bever employees during our onboarding day, and investigating the internal onboarding/education platform, it became apparent that the company’s identity consists of four pillars. These pillars include: Best Product, Best Inspiration, Best Expertise, and Best Services. These four pillars represent what is central in the operations of

1.3.1. Best Product

Bever aims to offer innovative, high-quality outdoor products that ensure worry-free adventures in any conditions. Their collection features premium products from distinctive brands. To showcase these products, Bever utilizes product photography, detailed

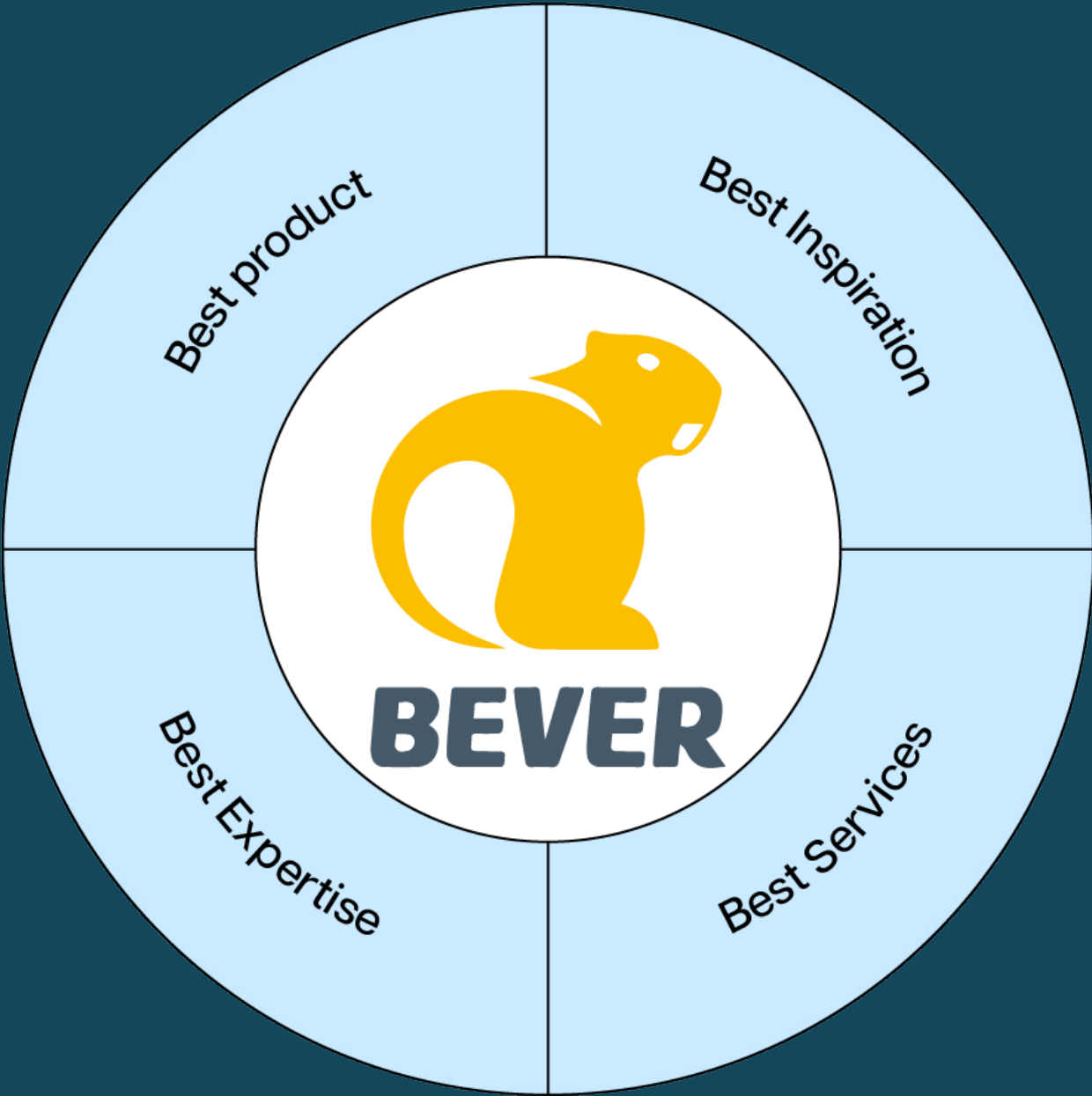
Bever. These pillars guide Bever’s approach to product selection, customer service, and overall business strategy.

By focusing on these core principles, Bever aims to differentiate itself in the outdoor retail market and provide a comprehensive experience for outdoor enthusiasts.

website descriptions, and engaging in-store presentations. With this approach Bever wants to highlight the uniqueness of their offerings and explains Bever’s rationale for selecting each product.

wants to achieve through advertisements campaigns, their product range, their physical stores, and the events that they organize, such as the Bever Dutch Mountain Trail.

proper onboarding, training, and growth to transform their employees from Outdoor Enthusiasts to Outdoor Experts. However, Bever does not only show this expertise through their stores and employees. The company also provides information via blogs, product information, photography, and reviews to guide customers.



1.3.4. Best Inspiration

Bever tries to extend product life through offering maintenance, repairs, and reuse services, helping customers enjoy Bever products (and the outdoors) longer. With this, Bever wants to contribute to reducing waste and benefiting the planet.

Bever offers maintenance advice, DIY instructions, and necessary tools through their physical stores and web-store.

1.3.5. A Gap for Our Project

In conclusion, Bever’s four-pillar identity and sustainability service center demonstrate the company’s commitment to environmental responsibility and sustainable practices. By offering maintenance, repairs, and recycling services, Bever tries to extend product lives, reduce waste, and meet the growing demand for sustainable practices in outdoor retail. Their Second Chance and Buitenmens collections further demonstrate their innovative approach to sustainability, aligning with company values and consumer expectations.

Despite these efforts, there remains a gap between Bever’s sustainability initiatives and

Moreover, Bever has a sustainability service center where multiple services are provided to customers. In this center, wash services and repairs of customer products are handled. Worn or broken items are resources for new beginnings. Bever gives them a second life as Second Chance products, through donations, or recycling into materials for Bever’s Buitenmens collection.

consumer behavior regarding product care. For example, during our onboarding day, multiple Bever employees mentioned that they see that their customers struggle with maintaining their products. This project aims to address this gap by developing a solution that encourages and simplifies the process of maintaining technical outdoor garments by consumers. By doing so, we hope to grant people the means to more easily extend product lifespans, and reduce environmental impact, while strengthening Bever’s position as a leader in sustainable outdoor retail with a solution that reverberates the organization’s vision.

1.4. Bever’s Target Audience

According to conversations with Bever employees about Bever’s customer base (C. Kalmthout, personal communication, July 16, 2024), they have said that their target audience is quite broad. Bever wants to encourage all of the Netherlands to be active in the outdoors, as is also apparent from their 2021 campaign (Bever, 2021). This broad target audience has to be analyzed to find common characteristics and behaviours that could be leveraged for our future design.

There is a clear distinction between Bever customers, namely, there are two main types of customers that Bever caters to.

- On one hand, there are **casual outdoor enthusiasts** who seek high-quality products for everyday outdoor activities; for example, rain jackets for walking their dog.
- On the other hand, there are **outdoor specialists** who require specialized gear for more intense outdoor pursuits, like equipment for a sub-zero camping trip.

This distinction helps Bever tailor its product offerings and marketing strategies to meet the diverse needs of its customer base. Moreover, since three years ago, there’s been a pivot in Bever’s focus towards the outdoor specialist, as Bever aimed to position itself as the go-to brand for serious outdoor enthusiasts seeking specialized gear (L. Leeuwenburg, N. Ruijsbroek, personal communication, July 16, 2024).

1.5. Characteristics from Bever Data

According to Bever customer research (see confidential appendix A) their customer base has the following characteristics:

1.5.1. Mentality

Bever consumers fall under three main mentalities: the Responsibles, Status Conscious, and Developers. The Responsibles are people that are intrinsically motivated to live and act sustainably. The Status Conscious act towards sustainability as a means of showing of status, or because it is financially beneficial. Lastly, the Developers actively search for new experiences. They want to be sustainable, as long as it does not inhibit their freedom (Motivaction, 2020).

1.5.2. Income

Bever’s customer base typically consists of individuals with middle to high incomes. When looking at Dutch statistics from the CBS (2023), and the Dutch tax brackets of 2024 (Belastingdienst, 2024) this means that individuals in the Netherlands have around 40.000 - 70.000 Euro for middle income, and 70.000+ Euro for high income.

1.5.3. Age

From statistics provided by Bever, and conversations with employees, their largest customer group consists of people between 25-34 and 65-74 (on average of minimum of 30.000 customers per age group). Another interesting thing to note about Bever’s customers, is that the average age of people buying their first product at Bever has lowered from 57 to 51.



Figure 5. Example of Outdoor Enthusiasts (Bever, n.d.-b).

1.6. Key Takeaways

1. Bever’s sustainability commitment is demonstrated through their dedicated service center offering repairs, washing, and recycling, along with their innovative ‘Buitenmens’ collection made from recycled materials.
2. The company implements sustainability across all retail touchpoints through service desks and collection bins for used products.
3. While Bever’s four-pillar identity (Best Product, Best Inspiration, Best Expertise, and Best Services) provides a strong foundation, there remains a gap between these initiatives and consumer behavior in product care.
4. The target audience consists of two main groups (casual enthusiasts and specialists) with three mentality types (Responsibles, Status Conscious, and Developers).
5. The customer base has middle to high income levels (40,000-70,000+ Euro) and spans two main age groups (25-34 and 65-74), with a trend toward younger first-time customers.

These findings indicate the need for a flexible solution that serves various user types and age groups while balancing sustainability and practical benefits.

2. Theoretical Foundations of the Circular Economy

This project is focused on the principle of product care, which fits under the Circular Economy. A model for production and consumption that can contribute to a resource cycle that avoids resource exhaustion by focusing on recirculating them. This chapter is an exploration of the Circular Economy and its role in sustainable product design.

The papers analyzed in this chapter were systematically searched for through academic search engines such as Google

Scholar and Web of Science, using key words including “circular economy”, “design for ease of maintenance”, “product maintenance”, and “sustainable product care”. The papers discussed in this chapter were chosen for their relevancy to the context of our thesis. By examining the fundamental principles and evolution of the circular economy, we can better understand how product care and maintenance contribute to resource conservation. This theoretical foundation will help inform our approach to improving TOG care practices.



Figure 6. (Seymour, 2020)

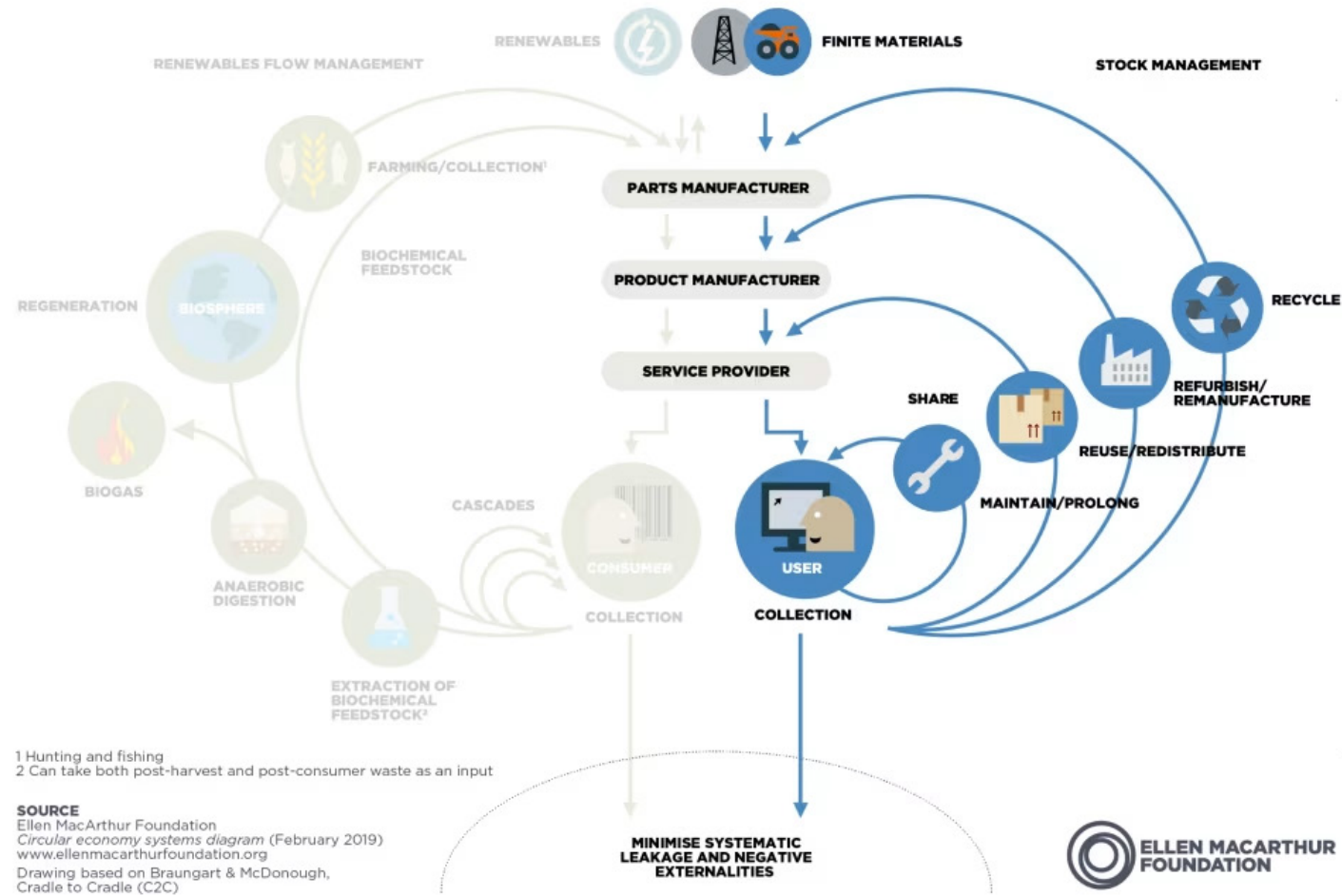


Figure 7. The technical side of the butterfly diagram (The Ellen MacArthur Foundation, 2019)

2.1. The Butterfly Diagram

The butterfly diagram by the Ellen MacArthur Foundation (2019) depicts a circular economy model for materials and products. This diagram illustrates how products and materials can be kept in use through various strategies. There are two cycles central in this diagram - the technical and biological cycle. For the context of this thesis only the technical cycle is relevant, since this cycle encompasses products and non-biodegradable materials.

This technical cycle shows that product circularity is comprised of multiple loops, ranging from large to smaller loops. From these loops, the smaller loops capture the most

value because the product remains intact, thus retaining more of its original value (The Ellen MacArthur Foundation, 2022). This refers to the sharing, maintaining, and reusing loops. When looking at the diagram, we can see that maintaining/prolonging is part of the smallest loop. This emphasizes that maintaining products is one of the most effective strategies for keeping materials in use and maximizing their value. By focusing on maintenance, we can achieve the highest level of circularity and resource efficiency according to this model.

Furthermore, the diagram illustrates that maintenance activities are crucial in preventing products from prematurely

moving to larger, less efficient loops such as recycling or disposal. This reinforces the importance of developing a solution that will facilitate product care of technical outdoor garments, as it aligns perfectly with the circular economy principles represented in the butterfly diagram.

2.2. The Evolution of the Circular Economy

The butterfly diagram is a contemporary depiction of the circular economy. Research by Reike et al. (2017) explains how the circular economy went through three phases to reach the current “version” that we are familiar with.

2.2.1. Implications for Our Context

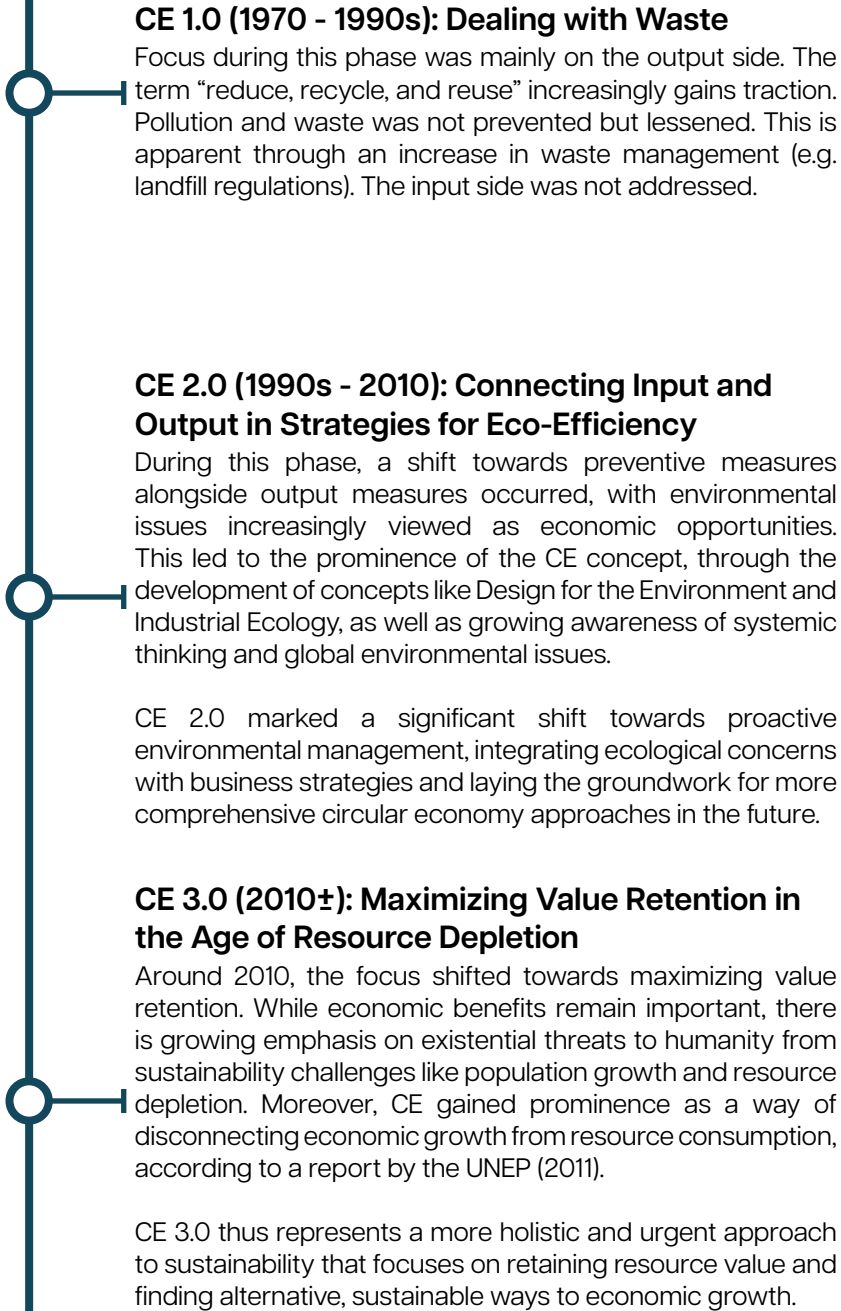
The evolution of the circular economy concept, as described by this paper, is interesting because this thesis aligns closely with the CE 3.0 phase.

The project’s focus on maximizing TOG value retention through improved product care participation aligns directly with the CE 3.0 phase. This emphasizes the importance of the research in addressing current sustainability challenges and resource depletion concerns.

The CE evolution also highlights how tackling environmental issues can be an economic opportunity. Our project could be an economic opportunity for Bever; Our design could provide their consumers a circular solution that could extend the lifetime of owned or newly purchased products. In the outdoor retail market, Bever already has an competitive advantages with their dedicated service center and collection model for consumer’s discarded products. These could be leveraged for our design, with which we could utilize Bever’s unique resources and competencies to add another layer to their existing competitive advantage in the outdoor retail market.

Lastly, CE 3.0’s more comprehensive view of sustainability reinforces the need for this project to consider not just the immediate benefits of proper TOG product care, but also its broader implications for resource conservation and sustainable consumption patterns.

This understanding helps validate our focus on TOG product care as a key strategy for value retention, while also highlighting how our approach aligns with contemporary sustainability challenges.



2.3. Types of Maintenance

Having established the evolution and current state of the circular economy, it is important to understand the different types of maintenance that can contribute to extending product life cycles and maximizing value retention. Fontana et al. (2021) provide a systemic literature review of notable papers about or related to the circular economy (CE) and life cycle extension, with a focus on the machinery and equipment industry. While its original purpose was to provide a clear understanding of CE definitions and strategies for small and medium enterprises, the paper also discusses information about CE that is relevant to this project. Notably, it offers revised definitions of various types of maintenance.

Corrective maintenance

This includes activities performed on a broken product to return it to its original, functioning state. In other words, corrective maintenance means to repair a product.

Preventive maintenance

The performance of inspection and/or service activities that were pre-planned to keep functionality and reduce the risk of failure and degradation. There are sub-types to this maintenance strategy:

- **Predictive maintenance** → Through direct monitoring of the condition of a product, and other indicators, the time to failure or loss of efficiency is determined.
- **Time-based maintenance** → Preventive maintenance sub-type. Restoring or replacing parts regardless of condition. The maintenance is done based on time intervals or operating time.
- **Condition-based maintenance** → Measured condition of a product or part is the reason for maintenance.

2.3.1. Implications for Our Context

In conclusion, this paper provides inspiration for our future ideation and development phases. When we review the strategies, corrective maintenance resembles the act of repairing. We will focus on preventive maintenance. Predictive and condition-based maintenance are promising strategies. Both strategies use some kind of monitoring to justify maintenance.



Figure 8. The Fairphone 5, a modular smartphone and example of Design of Ease of Maintenance and Repair (Fairphone, 2023)

2.4. Design for Ease of Maintenance and Repair

Design for ease of maintenance and repair is a design principle that enables products to be easily repaired or maintained. This design approach is a strategy to slow resource loops (Bocken et al., 2016), meaning that it caters to the principles of the Circular Economy. In cases where this design principle is used to create a product-service system, there is an opportunity to generate additional revenue. Bever actually already does this through their repair and maintenance services, and the repair and maintenance products that they offer.

Some design features that facilitate maintenance could provide: clear care instructions, an intuitive cleaning process or easily accessible maintenance components. Additionally, ensuring easy access to care products and providing clear visual guides for maintenance procedures can help overcome barriers to proper product care. The design should also consider incorporating features that make it obvious when maintenance is needed, such as visual indicators of wear or contamination. These design elements not only make maintenance more approachable but also help establish regular care routines.

This principle fits our project's maintenance scope, as proper maintenance can significantly extend TOG lifespan and performance. By incorporating design features or a product-service system that facilitate easy TOG product care, Bever can essentially empower consumers in the process. This approach not only benefits the environment by reducing waste but could also economically benefit Bever, as this approach could enhance customer satisfaction and brand loyalty (Wolf & Becker, 2023).

2.5. Key Takeaways

1. The Butterfly Diagram and Maintenance:
 - Smaller loops in the technical cycle capture the most value by keeping products intact
 - Maintenance is part of the smallest loop, making it one of the most effective strategies for maximizing resource value
2. Circular Economy Evolution:
 - Evolved from waste management (CE 1.0) to eco-efficiency (CE 2.0) to value retention (CE 3.0)
 - Current CE 3.0 phase focuses on maximizing value retention while addressing sustainability challenges
3. Types of Maintenance:
 - Corrective maintenance: repairs broken products
 - Preventive maintenance: includes predictive, time-based, and condition-based approaches
4. Design for Maintenance:
 - Features should include clear care instructions, intuitive cleaning processes, and visual indicators for maintenance needs
 - Can benefit both environment and business through extended product life and increased customer satisfaction

This literature review gave us a better understanding of the circular economy and the importance of maintenance within it. Ultimately it provides us with a theoretical background that informs our approach to designing a solution that encourages TOG care.

3. What Are Technical Outdoor Garments?

Technical Outdoor Garments, hereinafter abbreviated to **TOG**, refer to clothing made from technical textiles. These textiles are engineered and manufactured for specific functional purposes, which can range from fabrics made for industrial environments to medical applications (Pidilite Industrial Products, n.d.).

For this research, and the outdoor context for which Bever sells clothing, we focus only on TOG that protect the user from weather conditions such as rain, wind, and extreme temperatures. This includes waterproof, water-resistant, water-repellent, down-fill, and synthetic-fill garments. Their specialized construction and features make them

essential for outdoor enthusiasts, hikers, climbers, and other outdoor adventure seekers who require reliable protection of the elements.

Furthermore, TOG also represent a significant portion of Bever’s business. In fact, according to their sales numbers of 2024 (Confidential appendix B) , TOG are their most sold product category. This high demand underscores the importance of these garments to outdoor enthusiasts and highlights why proper care and maintenance of these products is crucial for customer satisfaction, Bever’s business model, and the organization’s dedication to sustainability.

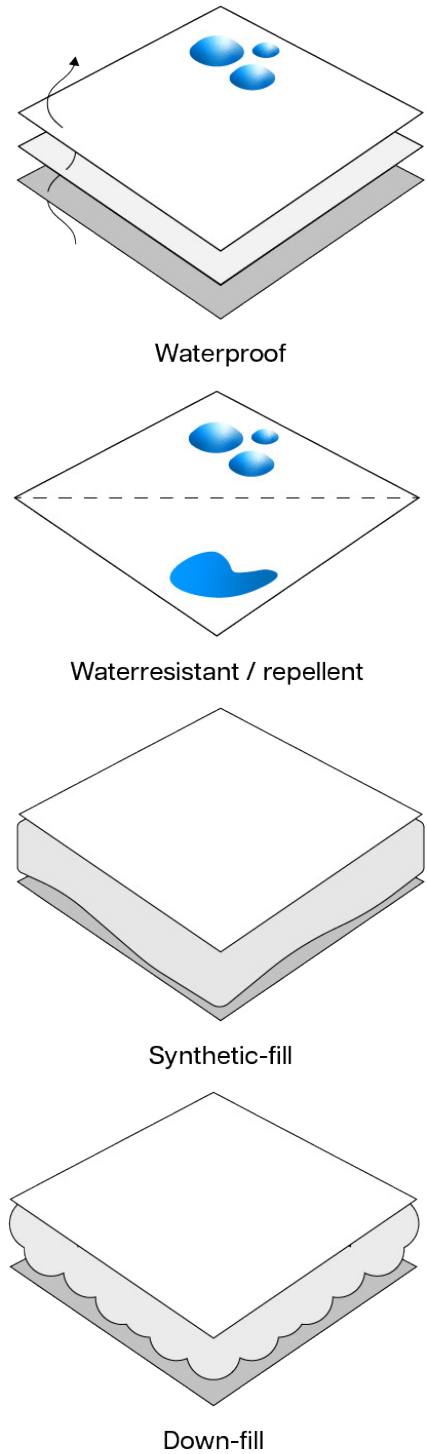


Figure 9. Most common TOG types



Figure 10. Arc'teryx Alpha SL 2.5L jacket (Super-Alpine, 2024)

3.1. Waterproof Garments

These garments have waterproofness as their inherent property. Depending on the intended use, these garments consist of 2, 2.5, or 3 layers, commonly referred to as 2L, 2.5L, and 3L respectively. These layers typically consist of an outer shell layer, a waterproof and breathable membrane, and an abrasion-reducing liner. The composition, quality, and thickness of materials directly influence waterproofing, weight, bulk, breathability, and durability. These important factors contribute to the intended use-context of a waterproof garment. There are three main variants of waterproof garments available on the market today (Rain Jacket Construction: 2L Vs. 2.5L Vs. 3L, 2023):

- **2L Garments:** Constructed of two layers—an exterior fabric and a bonded membrane—generally protected from abrasion by a mesh liner. These garments are typically more affordable and suited for casual use scenarios like commuting.
- **2.5L Garments:** Composed of an exterior fabric, a membrane, and a protective coating applied to the membrane. This coating serves as abrasion protection. 2.5L garments offer a more durable and lightweight option compared to 2L garments.
- **3L Garments:** Distinguished from the other two variants by having the membrane laminated between the outer fabric and the liner. Unlike 2L and 2.5L garments, the liner is neither sprayed on nor a separate mesh but integrated with the other two layers. This construction results in improved breathability, durability, and comfort. 3L garments are generally more premium and suited for serious use cases like climbing mountains in sub-zero conditions.

Many well-known outdoor brands offer waterproof garments. Some of the top brands in this category, as sold by Bever, include, but are not limited to: Arc'teryx, Patagonia, Jack Wolfskin, and Columbia. These companies are renowned for their high-quality waterproof clothing.

3.2. Water Repellent/Resistant Garments

There is some unclarity about the difference between water repellent, water resistant, and waterproof garments. The difference is as follows: As previously explained, waterproof garments feature a construction with a waterproof membrane. Water resistant garments often feature tightly woven fibers, that water struggles to seep through. Water repellent garments, on the other hand, are specifically designed to repel water droplets from their surface. This is achieved through the application of a hydrophobic coating, such as a DWR treatment. The key distinction lies in the mechanism of protection: water resistant garments rely on fabric structure, waterproof garments rely on their membrane, and water repellent garments depend on surface treatment.

Because we already explained waterproof garments, will not delve deeper into this mechanism. Instead, we'll focus on how water repellency and resistance are often combined to enhance protection. Water resistant and water repellent properties can be combined in a single garment. The tightly woven fibers provide water resistance, while the DWR coating enhances the garment's ability to repel water droplets. This combination offers improved protection against light rain and moisture compared to standard fabrics. Which is utilized in products that are made for casual use and drier conditions. Lastly, this combination can also be applied to waterproof garments' outer fabric to gain complete protection.



Figure 11. A water-resistant/repellent softshell jacket (Klättermusen, n.d.)



Figure 12. A Rab down-fill jacket (Rab, n.d.)

3.3. Down-fill Garments

Down-fill garments are insulated with down feathers of waterfowl. 'Down' is the undercoat of these birds, consisting of fluffy, light feathers closest to the bird's body, that trap air due to their three dimensional structure (Government of Canada & Competition Bureau Canada, 2000). This causes lightweight, compressible, resilient, and breathable properties, ideal for the outdoor context that TOG are used in.

Regular down feathers are prone to losing their insulating characteristics when getting wet, because the insulating air pockets disappear. To avoid this problem, Hydrophobic down also exists. These are down feathers treated with a DWR treatment to enable water resistance, and quicker drying. The process essentially creates an insulation that is suited for damp conditions, where contact with water is more common (Ultralight Outdoor Gear, 2022).

There are two measurements that indicate the insulation capacity of down: down fill power and down fill weight:

1. Down fill power is a measure of the loft or "fluffiness" of down insulation. It indicates how many cubic inches one ounce of down will occupy when allowed to reach its maximum loft (*Down Fill Power: Explained*, n.d.). Higher fill power numbers (e.g., 800 or 900) indicate better insulating properties, as the down can trap more air and provide more warmth for its weight. This makes higher fill power down more desirable for technical outdoor garments, as it offers superior warmth-to-weight ratio.
2. Down fill weight is a measure of the amount of down that has been stuffed into a garment. This measurement is important, as it determines how warm a garment will be. Clothing with a higher down fill weight will be warmer than those with a lower fill weight. A higher fill weight comes at a price, however. A more filled garment means a heavier and less compressible garment (Alpine Ascents International, 2019). This fill weight is often indicated with ounces and/or grams.

These two measurements work together to determine the overall warmth and performance of a down-filled garment. While a higher fill power indicates better quality down, the fill weight determines the total amount of insulation. TOG brands often balance these factors to create garments suited for different activities and weather conditions. For example, a lightweight jacket for mild weather might use high fill power down but with a lower fill weight, while a heavy-duty winter coat could use the same high-quality down but have a much higher fill weight for maximum warmth.

3.4. Synthetic-fill Garments

Synthetic-fill garments are insulated with synthetic fibers that mimic the structure and properties of down feathers. This insulation is typically made from polyester and provides an advantage over down feathers (Pasteris & REI Co-op, n.d.). Specifically, synthetic insulation offers better water resistance and better insulation when wet. This causes the synthetic insulation to stay warmer when it gets wet, and dry out faster. On the other hand, after compressing and handling synthetic insulation, it packs out over time and loses the ability to ‘fluff’, resulting in a shorter lifespan than down insulation (Switchback Travel, 2020).

Synthetic insulation is not measured the same way as down. Warmth is measured in

grams per square meter (gsm), this does not indicate the amount of insulation used in a garment.

The current market offers various synthetic down options, with different brands to choose from. Primaloft *t* is one of the most prominent independent brands on the market that produces different versions of synthetic insulation, suited for various use scenarios. Outdoor gear brands also often have developed their own in-house synthetic insulation. To name some examples: The North Face has Ventrix, Patagonia has PlumaFill, and Arc'teryx has Coreloft. While these technologies may have slight nuances, they all work relatively similar by mimicking the behaviour of down feathers.



Figure 13. A Patagonia jacket filled with synthetic Primaloft insulation (Patagonia, n.d.-b)

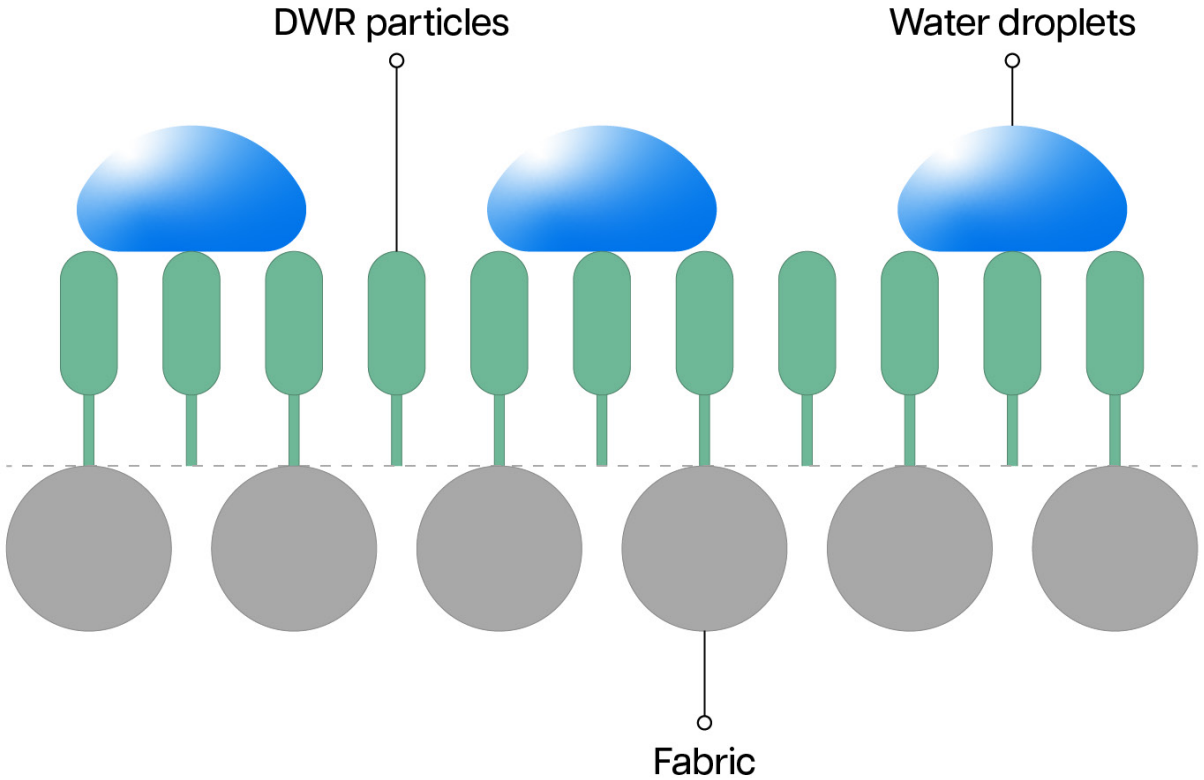


Figure 14. Close-up of how DWR works

3.5. Durable Water Repellent (DWR)

A DWR is a crucial feature of TOG—it is a chemical coating that makes the outer fabric water-repellent by creating a barrier that increases surface tension between water droplets and the fabric (REI Co-op, n.d.). A DWR acts as the first exterior barrier against water, allowing droplets to roll off instead of seeping in, thus creating complete water protection when combined with the earlier mentioned multi-layered constructions. The coating is applied in factories through dipping or spraying, but over time, contaminants and abrasion cause it to deteriorate and lose its hydrophobic properties. More about restoring this hydrophobicity is explained in section 4.2.

3.5.1. DWR Controversy

Although innovative, DWRs have experienced controversy due to the use of per- or polyfluorinated chemicals in the coatings. By containing fluorine in their composition, some DWRs classify as ‘forever chemicals’, which accumulate in the environment and animals, including humans, and are harmful to organic life (Directorate-General for Environment, 2023). This controversy has urged brands to invest in DWRs that avoid the use of PFCs and/or PFAs, with companies like Patagonia developing their own DWR finish that contains no PFAs or PFCs (Made Without PFCs / PFAS - Patagonia, n.d.).

3.6. TOG Overview

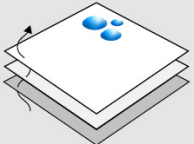
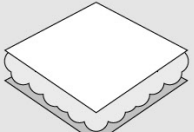
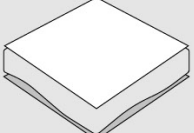
		Waterproof?	Water-repellent?	Breathable?	Insulating?	Price?
	 Waterproof	Yes, due to multi-layer construction	Yes	Yes, due to multi-layer construction	No	Depends on construction. More layers means a higher price
	 Water-repellent	No	Yes	No, unless specified by manufacturer	No	Lower price range
	 Water-resistant	No	No	No	No	Lower price range
	 Down-fill	No, unless combined with waterproof construction	Yes, most have a DWR	No	Yes	Depends on construction. More layers means a higher price
	 Synthetic-fill	No, unless combined with waterproof construction	Yes, most have a DWR	No	Yes	Depends on construction. More layers means a higher price



Figure 15. Laundry line-drying (Spratt, 2018)

4. What is Product Care?

Activities initiated by the consumer that contribute to extending the lifetime of a product refer to product care (Ackermann et al., 2021). Product care is broad terminology, as it includes activities such as repairing and cleaning, but also preventive measures like installing a screen protector for a phone.

In the context of this thesis, we relate product care to the washing and drying activities of technical outdoor garments, because it is the primary method for product care before a garment needs repairing. Like regular clothing, TOG require washing for hygiene.

Proper washing is essential for extending product lifespan and maintaining protective features. Incorrect care can irreparably damage TOG (Gore-Tex, n.d.). This makes laundry practices a key product care aspect of TOG.

Moreover, this scope was also suggested by Bever, as they have experienced barriers with product care practices through their customer service, and even conducted research about the topic (more in chapter 5.3).

4.1. Washing & Drying

Due to sweat, dirt, smoke, and other contaminants, TOG need to be washed regularly to maintain their performance and longevity. However, washing these garments requires special care because of their materials and construction, as is explained by brands that produce these types of clothing (Gore-Tex, n.d.).

Unlike regular clothing, TOG should be washed using specific detergents that are designed for technical fabric. These gentler detergents lack the additives found in regular detergents. These could damage the garment or reduce its protective properties. Some technical detergents are specifically formulated to help preserve the DWR coating (OrganoTex, 2024a).

4.2. DWR Restoration

When a TOG has lost its water repellency, it needs restoring. A TOG's DWR can experience mild or complete deterioration. With mild deterioration, a DWR can be restored by applying heat. This “reactivates” the DWR. According to OrganoTex, the company that produces Bever's DWR products, activating their DWR is done at low tumble dryer settings (OrganoTex, 2024b), which is commonly around 50 °C (Whirlpool, 2023).

When a TOG suffers complete DWR deterioration, it has to be reapplied. Some brands offer DWR reapplication services, while consumer DWR reapplication is also possible. This is achieved at home with spray-on or wash-in consumer products

Proper drying is equally important for maintaining the performance and longevity of TOG. After washing, these garments should be air-dried or tumble-dried on low heat, depending on the manufacturer's instructions . Air-drying is often preferred as it's gentler on the garment. Some garments may benefit from a brief tumble dry on low heat to reactivate the DWR treatment, but this should be done carefully to avoid damaging the fabric or membrane (Pertex, n.d.).

Interesting to note is that down-fille garments often need to be “fluffed” in order to restore the loft in the clothing. This can be achieved by adding tennis balls into the dryer to help break up any feather clumps (Jack Wolfskin, n.d.), doing this manually is also possible.

specifically designed for TOG. Nikwax is an example of a popular brand that offers consumer DWR reapplication products, and Bever also sells their own product (Bever, 2023; Nikwax, n.d.). Spray-on products are designed for garments with DWR loss in specific areas, while wash-in products address severe DWR deterioration across larger areas or entire garments. An essential step to finishing the reapplication process is by applying “low” heat with a tumble dryer or alternative heat source (like a fohn or an iron).

Lastly, it is important to note that while consumer DWR reapplication is possible, the DWR coating from this method is often less durable than DWRs applied during the manufacturing process.



Figure 16. Nikwax wash-in & Buitenmens spray-on waterproofing products

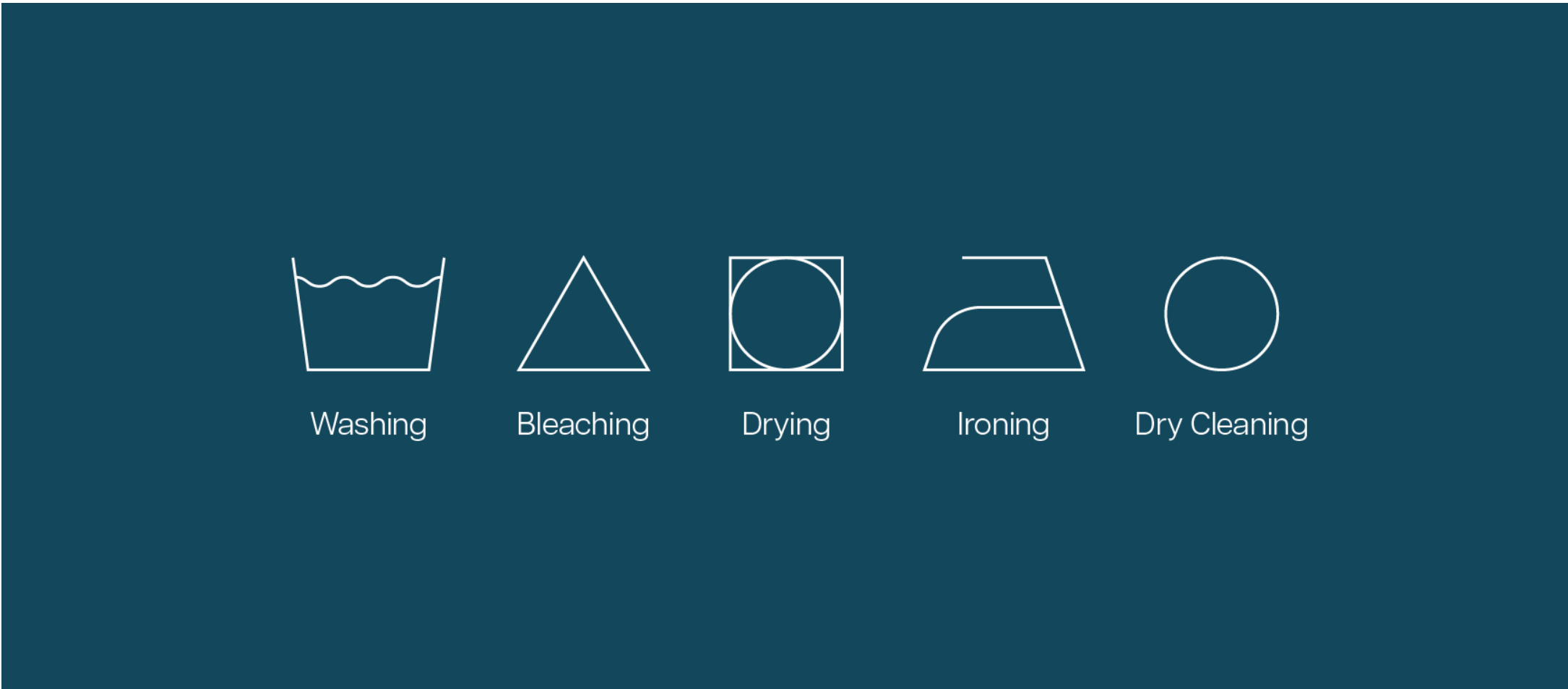


Figure 17. The five care label icons

4.3. Care Labels

Care labels are the most commonly provided product care guide for TOG. These labels, attached to the inside of clothing, contain information about the garment's composition and proper washing and drying instructions. This essential information includes symbols and text that indicate recommended washing temperatures, drying methods, ironing instructions, and any special care requirements.

Ginetex, a French-European that cooperates with the ISO (International Organization for Standardization) to create internationally applicable, standardized icons for care labels (GINETEX, n.d.-a). These icons are divided into five categories: Washing, Bleaching, Drying, Ironing, and Professional Care (figure 17. from left to right).

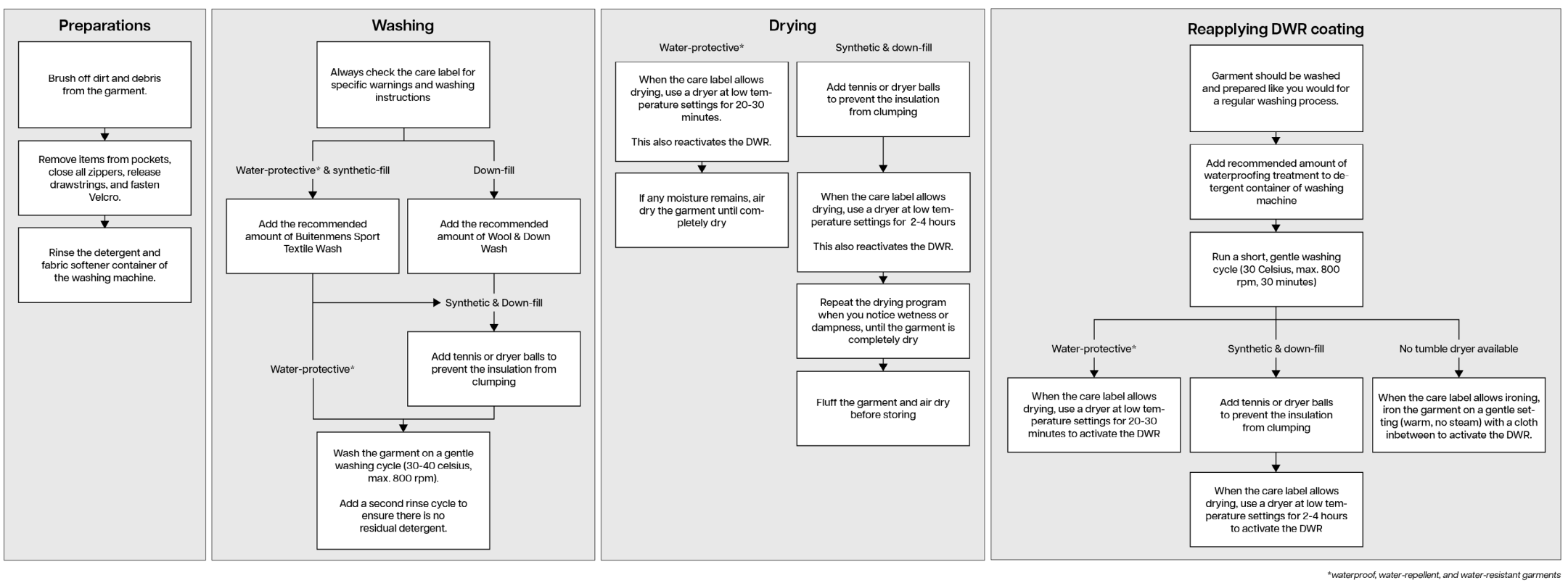
However, even though these symbols have been standardized for many years, people still seem to struggle with the interpretation or understanding of these care labels. In a study by (Gwilt, 2021), only 40% of people followed provided washing instructions.

Furthermore, Feltham and Martin (2006) argue that their focus group participants were overwhelmed and confused about the Canadian care labeling system that was recently updated at the time of the study.

The lack of comprehension in consumers is apparent from these studies, which is problematic, as it can lead to improper care practices, potentially damaging garments and reducing their lifespan. This lack of understanding highlights a need for clearer guidance that consumers can follow when caring for their (technical outdoor) garments. Which can be tackled during the course of this project.

4.4. Product Care Instructions per TOG

According to our collection of information from brands’ and Bever’s own tutorials about correct TOG care (Bever, 2024b; Bever, 2024c; Patagonia, n.d.), we created an overview of correct care instructions for the TOG types we defined. We also compiled common care label symbols.



Washing



Wash normal,
95 °C



Wash gently,
30 °C



Wash very
gently, 30 °C



Hand wash



Do not wash

Bleaching



Any bleach



Only non-chlorine
bleach



Do not
bleach

Drying



Medium
heat



Low
heat



Line
dry



Drip line
dry



Flat
dry



Drip flat
dry



Dry in
shade



Do not
tumble dry

Ironing



High heat



Medium heat



Low heat



No ironing



No steam

Dry cleaning



Perchloroethylene &
hydrocarbons only



Hydrocarbons
only



Wet
cleaning



No dry/wet
cleaning



Gentle
wash



Very gentle
wash

5. Consumer Behaviour Background and Industry Insights

At the root of the problem lies consumer behaviour. To comprehend consumer behaviour is crucial when we want to address the challenges of TOG product care. This chapter explores behavioural models and Bever’s insights to help in explaining why consumers may or may not engage in proper maintenance. Through this examination of consumer behaviour research related to product care, including Bever’s own investigations and industry benchmarks, we can better understand the barriers and opportunities for improving TOG maintenance practices.

The chapter begins by introducing the Fogg Behavior Model (FBM) as a theoretical framework for analyzing consumer behavior. This is followed by an adaptation of the model to product care activities. We then review Bever’s previous research findings on customer maintenance habits and conclude with a benchmarking analysis of existing maintenance-promoting products in the market.

These insights will form the foundation for developing effective solutions that encourage proper TOG care among consumers while addressing the identified behavioral barriers and leveraging proven motivational factors.



Figure 18. People in a shopping mall (Guetar, 2023)

5.1. The Fogg Behaviour Model

Originally developed for digital persuasion purposes/products, the Fogg Behaviour Model is a framework that can help designers and researchers to understand behaviour better. Fogg (2009) explains that there are three main factors that influence someone’s behaviour whenever they are present simultaneously: Motivation, Ability, and Triggers.

5.1.1. Motivation

How willing someone is to perform a target behaviour. According to Fogg (2009) three core motivators are at play according to Fogg (2009):

1. **Pleasure/Pain Motivator:** This dimension of motivation consists of pleasure and pain. Two primitive motivators, but very powerful. Result of this motivator is immediate, because people respond to what is happening in the moment.

Example: The satisfaction of a warm down jacket during winter due to proper maintenance (pleasure). The discomfort of wet, leaky waterproof pants due to poor maintenance (pain)

2. **Hope/Fear Motivator:** This dimension of motivation is characterized by hope and fear, two anticipatory factors.

Example: Reapplying DWR to protect from predicted heavy rainfall (fear). Extending a TOG’s lifetime through maintenance to keep using it as long as possible (hope).

3. **Social Acceptance/Rejection Motivator:** Plays into our need to fit in societal and social norms.

Example: Maintaining your TOG in good condition before a group hiking trip to fit in with experienced outdoor enthusiasts who take pride in their well-maintained gear (Social Acceptance). Feeling embarrassed when wearing a visibly dirty or poorly maintained TOG in public, leading to potential social discomfort (Social Rejection)

5.1.2. Ability

How able someone is to perform the target behaviour, in other words, how simple a target behaviour for someone is. Fogg mentions six elements of simplicity.

1. **Time:** How much time is needed for a target behaviour.
2. **Money:** How much a target behaviour costs financially.
3. **Physical Effort:** How much physical effort a target behaviour takes.
4. **Brain Cycles:** How much mental energy the target behaviour takes.
5. **Social Deviance:** How much the target behaviour goes against the social norm.
6. **Non-Routine:** How much the target behaviour fits into someone’s (daily) routine

5.1.3. Triggers

Something that triggers someone to perform the target behaviour at the moment the trigger is received.

1. **Spark:** When an individual lacks motivation, this trigger can be used. A spark can play into one of three motivational dimensions.
2. **Facilitator:** When an individual has high motivation but low ability. It communicates that the target behaviour is easy to do.
3. **Signal:** When an individual is both motivated and able, a signal acts as a reminder.

To conclude, this framework enables us to understand how motivations, ability factors, and triggers collaborate to produce a target behaviour. It is important to note that these three factors have to happen at the same moment in order to influence behaviour. They can be at various levels, and can compensate for each other. Also, every person is different, meaning that each of these factors vary per person. These factors can vary per context too.

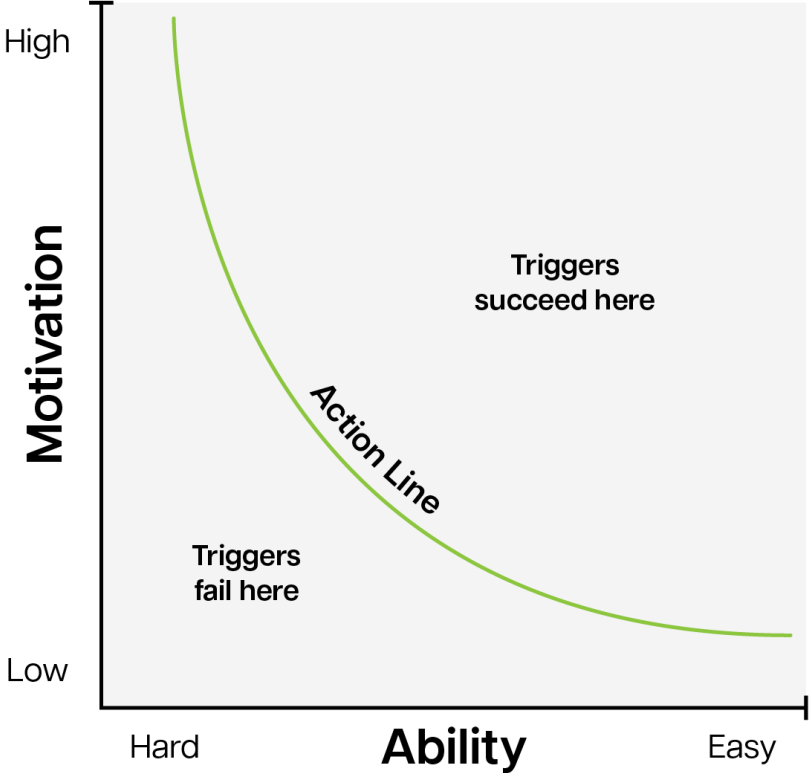


Figure 19. The FBM visualized

5.2. The Fogg Behaviour Model Applied to Product Care

Ackermann’s research builds on the Fogg Behaviour Model and aims to identify existing motivators, ability factors, and triggers related to product care across various product categories. Through in-depth interviews, the study found nine motivators, four ability factors, and five triggers (Ackermann et al., 2018).

5.2.1. Care Motivators

Product related motivators

- **Financial Aspects** → Price/financial value of product affects motivation
- **Pleasure** → Product provides joy or fun, playing into a human need and causing motivation.
- **Functionality** → A well performing, regularly used product can cause motivation towards product care.
- **Aesthetics** → Product’s aesthetics influence product care tendency.

Person related motivators

- **Intrinsic Motivation** → Product care is inherent to someone’s personality.
- **Rebellion Against Brand Policy** → Some people get motivated whenever a brand obstructs easy repair or maintenance.

Person-product relationship motivator

- **Irreplaceability** → Emotional attachment and fear for losing/damaging the product can work motivationally.
- **Fit with Identity** → Products fitting someone’s identity motivate them.
- **Shared Ownership** → Shared ownership may cause people to neglect product care.

5.2.2. Care Ability Factors

- **Knowledge & Skills** → Skilled people are more likely to care for products due to fewer barriers. The reverse is also true.
- **Time & Effort** → Costly time and effort negatively impact product care since people often lack this valued resource.
- **Lack of Tools** → Lacking tools is a major barrier to product care because it prevents people from performing necessary tasks.
- **General Lack of Repairability** → Something that can’t be repaired won’t be repaired by the average person

5.2.3. Care Triggers

External triggers

- **Appearance Trigger** → The appearance of a product triggers someone to maintain it. E.g. a white carpet that has become dirty
- **Time Trigger** → Some things are periodically cared for, independent of the product’s state. Sometimes this is paired with products that are regulated, such as cars.

Internal triggers

- **Social Trigger** → Product care is triggered because of social influences
- **Previous Care Activity Experience Trigger** → Previous experience of the caring activity left an impression that triggers someone to do it again
- **Challenge-based Approach Trigger** → An individual wants to challenge themselves by participating in the activity.

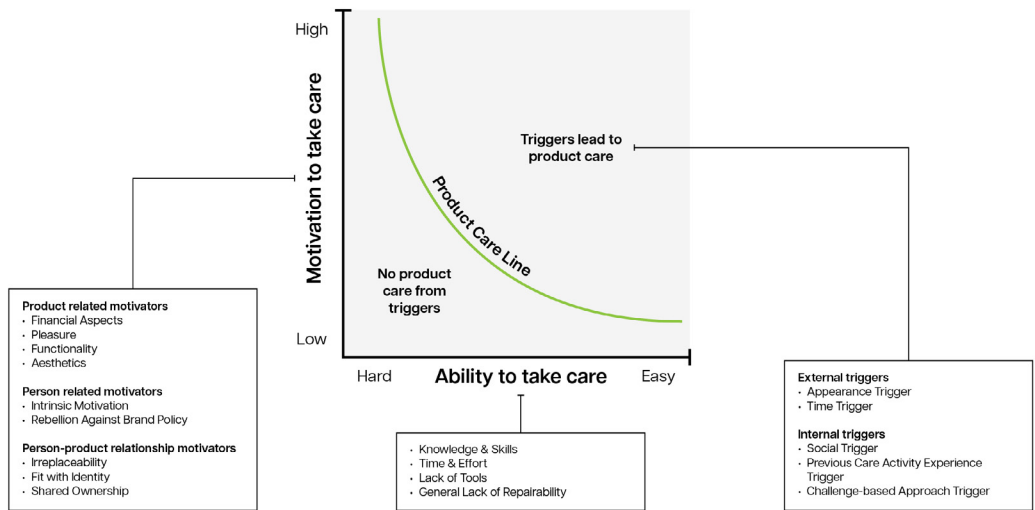


Figure 20. The adapted FBM

The application of the FBM to product care is relevant for this project’s investigation, as it provides an understanding of the factors that influence consumer behavior towards product care, which can be directly applied to the context of technical garments as well. The paper only focused on a broad group of product categories, so there is an opportunity for further, in-depth, investigation about product care behaviour of technical outdoor garments.



Figure 21. Example of available Bever services

5.3. Bever’s Previous Research

Bever previously conducted research about product care. The document can be viewed in confidential appendix C. Their problem definition in this research is as follows:

“The consumer enjoys their new product, but maintenance isn’t a priority, despite it being mentioned during the sale. As the product’s quality declines, satisfaction decreases.”

This research involved four areas where Bever investigated:

- **Customer questionnaire** → Customers were dichotomously asked if they partake in product care, followed by an open-ended question about their reasoning behind it.
- **Expert interview** → Interview with Category Manager Paul Eg about product care.
- **Store/Sales employee survey** → Employees were asked open-ended questions about perceived customer’s awareness about product care and product care tools. Product care recommendations were also requested.
- **Store team lead interview** → Interview with the team lead of one Bever’s stores.

Bever discovered that their customers say that they are partaking in product care because of performance purposes and to achieve a longer product lifetime. However, the data indicates that the customer is not taking (repeated) action on maintenance. This research indicates that the following factors cause this (Bever, 2024):

1. Product care is seen as effort (Time & Effort).
2. People are afraid to incorrectly care for products (Knowledge & Skills, Lack of Tools, Financial Aspects).
3. People do not recognize the need to partake in product care (Missing Trigger).

The main takeaway is that these results fall in line with the barriers of the original FBM and the adapted model by Ackermann et al. (2018). The first insight plays into the Time & Effort ability factor. The second insight relates to the Knowledge & Skills, Lack of Tools ability factors, and the Financial Aspects motivation factor. The third insight associates with a missing trigger.

While Bever investigated consumer behaviour and has shown that a problem exists, their scope was not aimed specifically at washing and drying practices or a specific product category. The customer survey questions were superficial, consisting of only three questions, and no clear foundation of consumer behaviour theory was applied for these questions. Therefore, we need to utilize a framework in our research to establish a solid foundation for our design approach.

5.4. Benchmarking Current Products

Through the lens of the Fogg Behavior Model (FBM), we’ve explored and analyzed several existing designs and products that are engineered to effectively trigger maintenance behaviors. The FBM identifies three key factors that influence behavior: motivation, ability, and triggers. Our analysis will focus on showcasing products that each showcase one of these factors:

- 1. Products that increases motivation for maintenance activities
- 2. Products that enhances the ability to perform maintenance activities
- 3. Products that provides an effective trigger for maintenance activities

By examining these products, we aim to gain insights into successful strategies for encouraging product care and maintenance. This benchmarking can serve as a source of inspiration during the ideation phase of this project.

Motivation	Ability	Trigger
		

Figure 22. Examples of products encouraging maintenance

Motivation

Raw denim is interesting. Maintaining a raw denim garment applies a customization effect. This can create a personalized garment with which the wearer has a stronger emotional connection with (Cimino, 2023).

Spanish textile designer Paula Ulargui Escalona created plant clothing in collaboration with Loewe (Chan, 2022). In this conceptual design, living organisms are integrated into the clothing, which would force the wearer to sustain the life of the plants in order to keep the appearance of the garments.

Ability

Kitchen appliance brands such as Miele offers self-cleaning ovens (*Miele Pyrolytic Ovens | Self Cleaning Oven | Miele*, n.d.). As the name suggests, these ovens have the ability to clean themselves, often done through high temperatures or with water to help remove any food residue stuck on the inside of the appliance. This removes the need to clean, or at least makes cleaning easier.

Some clothing brand sell wrinkle-free clothing. These clothes resist wrinkles, often achieved by their construction or a specific treatment. This removes the need for ironing, and makes maintenance easier for the user.

Trigger

Many contemporary, advanced coffee machines, that have a digital screen often indicate when maintenance has to be performed. This maintenance ranges from refilling the water container to cleaning internal components. The indication system helps to ensure optimal performance and longevity of the machine.

Toothbrush bristles from brands such as Oral-B have wear indicators (FlossAction Opzetborstels | Oral-B, n.d.). These bristles change colour after prolonged use, thus indicating whenever they have to be replaced.

5.5. Key Takeaways

- The Fogg Behavior Model provides a comprehensive framework for understanding product care behavior through motivation, ability, and triggers.
- Ackermann’s FBM adaptation to product care offers detailed insights into factors affecting maintenance behaviour, but there was no focus on TOG. This presents an opportunity to investigate specific maintenance behaviors in the context of technical outdoor garments
- Bever’s previous research, while valuable, was limited in scope and depth regarding TOG-specific care practices.
- Current maintenance-triggering products demonstrate various successful approaches to encouraging product care, which can be leveraged as inspiration for our design

There is a clear need for more detailed investigation into TOG care practices using the adapted FBM framework to fill the encountered research gaps. These takeaways have created our research direction for the next chapter: Investigating TOG care practices of Bever consumers through the adapted FBM model.

6. Investigating Product Care through the Fogg Behaviour Model

In this chapter we aim to investigate product care practices for TOG through the lens of the Fogg Behaviour Model and its adaptation by Ackermann et al. (2018). By applying the models from this research, we seek to gain a deeper understanding of factors that influence consumers' product care behaviour related to TOG. This investigation manifests itself in a survey format, and builds upon earlier mentioned consumer behaviour theory, while also addressing the gaps identified in Bever's previous research.

RQ

What is the experience of product care of Technical Outdoor Garments by people that own them, observed through the lens of the Ackermann et al. (2018) adapted Fogg Behaviour Model?

6.1. Pilot Study

Ackermann's research builds on the Fogg Behaviour Model and aims to identify existing motivators, ability factors, and triggers related to product care across various product categories. Through in-depth interviews, the study found nine motivators, four ability factors, and five triggers (Ackermann et al., 2018).

6.1.1. Goal

This pilot study meant to discover if there would be a significant completion time difference, and whether or not the surveys would take longer than 8-12 minutes; a maximum range that was advised by Bever and our supervisors. Additionally, the pilot also aimed to identify areas for improvement, ensuring that the final version would be suitable for distribution to participants.

6.1.2. Results

Based on the pilot study results, we observed that the open-ended version of the survey had a shorter average completion time (07:37,42) compared to the multiple-choice version (10:42,39). Despite this difference, both versions fall within the targeted 8-12 minute range, making this variation acceptable for our purposes. Moreover, one participant mentioned that they did not experience the multiple-choice version to be tiring or tedious, and that they could have answered more questions if the survey was longer, further confirming that this version is not cognitively demanding.

6.1.3. Direction for Definitive Survey

While the open-ended version resulted in slightly faster completion times, it's important to note that the multiple-choice format offers significant advantages in terms of data analysis. The multiple-choice questions provide structured responses that are easier to quantify and analyze statistically,

Therefore, considering that both versions meet our time requirements and given the analytical advantages of the multiple-choice format, we decided to proceed with the multiple-choice version for the main study. This decision balances participant experience with research efficiency, allowing for a more streamlined analysis process while still maintaining an acceptable survey duration.

6.2. Methodology

After the pilot study we created the definitive study. This section elaborates on the structure and content of the final survey version. The survey is designed to gather comprehensive data on consumer behavior related to the care of technical outdoor garments (TOG), using the by Ackermann et al. (2018) adapted Fogg Behavior Model as a theoretical framework. Surveys are an effective way to collect quantitative data from a large and varied sample of participants, which allows us to fully understand the factors influencing consumer behavior regarding TOG care.

6.2.1. Research Design

The survey is structured into four main sections, to see the full survey, please refer to appendix A. Each section contains a series of questions aimed at exploring different aspects of TOG care behaviour. The survey uses a combination of multiple-choice questions, Likert scales, multi-select questions, and open-ended questions to capture qualitative and quantitative data.

The survey has gone through multiple iterations to reach the definitive version that was used. The first version was assessed with Christian de Jong, Bever's Director of Sustainable services. The second version was assessed with this our supervisors. The third version was finally pilot tested into the definitive version.

6.2.2. Sampling Technique and Sample Size Determination

Purposive sampling was used to find a sample of 162 respondents. 118 participants were physically collected through Bever's stores. We approached people at two different Bever stores, on three different days. On the first day (26-9-2024) we collected participants in Bever's The Hague location, and on the second (27-9-2024) and third days (28-9-2024) we collected people in Bever's Leidschendam flagship location. 44 participants were collected through social media and WhatsApp.

6.2.3. Data Analysis Techniques

Data was collected through the Qualtrics survey platform. Collected data was exported as an .xlsx file, and imported into Excel to trim any incomplete or invalid entries from our dataset, cutting the respondent count down to 134. This provided us with a trimmed and organized version of the data that made it clearer for us to analyze. Finally, the dataset was imported to SPSS, where it was visualized and statistically analyzed.

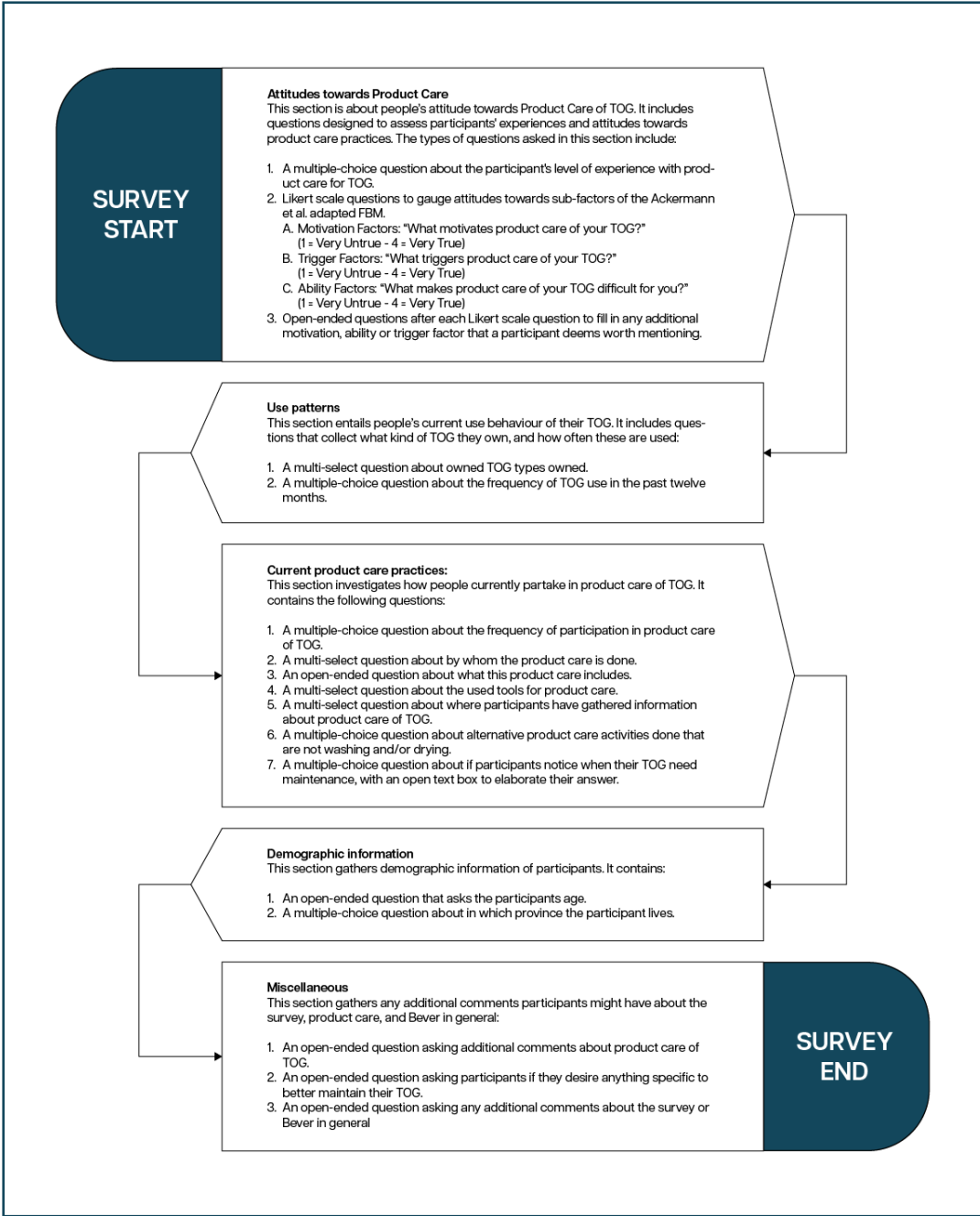


Figure 23. Survey flow visualized

6.3. Results

In this paragraph we analyze the data collected through the survey. Analysis was conducted on data from 134 valid participants.

6.3.1. General Descriptive Statistics

To determine which FBM factors are less influential in TOG product care participation, we examine the descriptive statistics of the survey data. The FBM questions used a Likert Scale, categorizing the data at an ordinal measurement level. Given the ordinal nature of the data, we focus on the median to identify the most common response for each factor.

Moreover, we can also examine other frequencies, like how many people participate in TOG product care and where people most commonly gather their product care information from.

Product Care Participation (figure 25)

Our data shows us that 74.2% (n=132) engage in TOG maintenance a few times a year. We can also observe that 22.0% never maintains their TOG.

When we cross tabulate Product Care Participation with TOG Use Frequency, we can observe that most people maintain their TOG a few times a year, while they use their TOG multiple times a week (n=45). This is not desirable. More frequent use also means that one should maintain their garments more often.

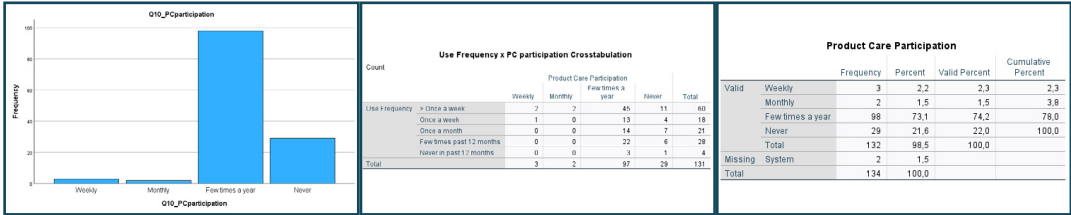


Figure 25. Alternative product care tool frequencies table & graph

Alternative Product Care Tools Frequencies (figure 24)

While 40.3% of respondents don't use alternative care tools, most use care products: 21.8% use wash-in products, 16.9% use waterproof spray, and 16.1% use both. This total usage of 54.8% contradicts the reported lack of proper tools for TOG maintenance.

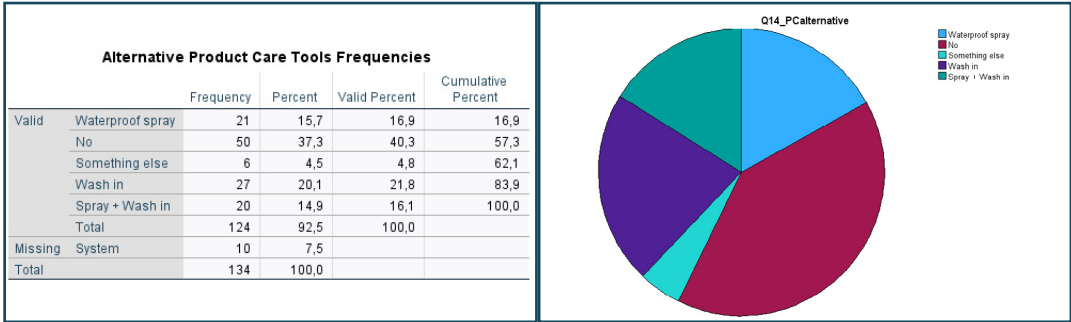


Figure 24. Alternative product care tool frequencies table & graph

Multi-response Question Frequencies

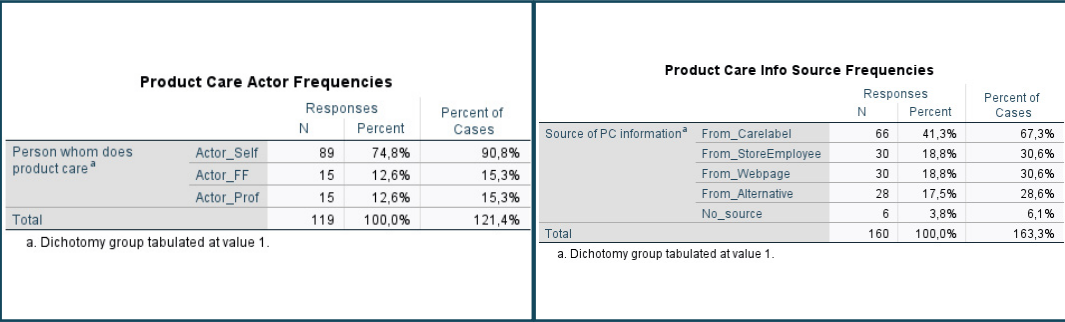


Figure 26. Product care actor frequencies table & graph

Multiple responses were possible, resulting in a total percentage over 100%. Self-care is the primary method (n=89), with some respondents also using friends/family (n=15) or professional help (n=15), often alongside self-care.

The total percentage of cases (163.3%) exceeds 100%, indicating that respondents often use multiple sources for product care information, with the care label being the most prominent source (n=66).

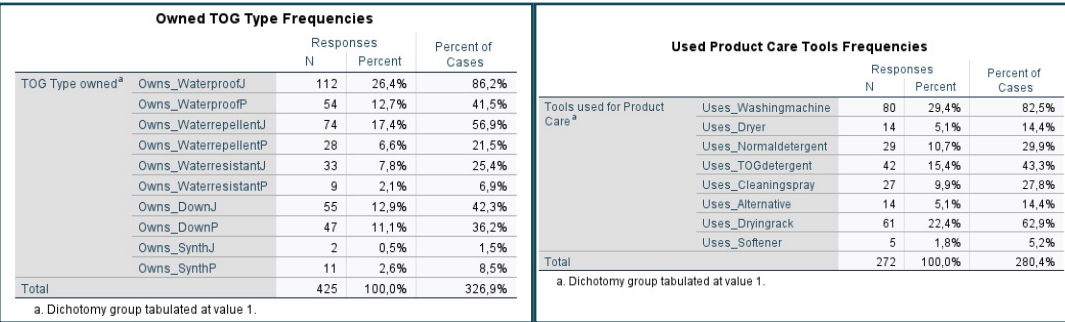


Figure 27. Owned TOG types & product care tools frequencies tables

Most respondents own multiple TOG types (326.9% total responses). Waterproof jackets are most common (n=112), followed by water repellent jackets (n=74), down jackets (n=55), waterproof pants (n=54), and down pants (n=47). Synthetic filled garments were least common, with only 2 jackets and 11 pants reported.

Most respondents use multiple product care tools, with the washing machine being most common (n=80), followed by drying racks (n=61). 42 people use specialized TOG detergent, while 29 use regular detergent and 5 use fabric softener - the latter two being discouraged for TOG care.

6.3.2. FBM Factor Analysis

Frequency tables for bar graphs can be viewed in appendix B

Motivation Factors

Motivation Factor Statistics									
		Financial Motivation	Pleasure Motivation	Fit with Identity Motivation	Functionality Motivation	Rebellion Against Brand Policy Motivation	Aesthetics Motivation	Intrinsic Motivation	Irreplaceability Motivation
N	Valid	134	134	134	134	133	134	134	134
	Missing	0	0	0	0	1	0	0	0
Median		3,00	3,00	3,00	3,00	2,00	3,00	3,00	3,00
Mode		3	3	3	3	2	3	3	3

Figure 29. Motivation factor median table

This table suggests that seven out of eight motivation factors are rated similarly by the participants, these have a median of 3.00 (True). People agreed with the following statements:

- Financial Motivation:** “The original price or financial value motivates me.”
- Pleasure Motivation:** “The TOG’s provided pleasure or joy motivates me.”
- Fit with Identity Motivation:** “The TOG’s alignment with my identity motivates me.”
- Functionality Motivation:** “The TOG’s functionality motivates me.”
- Rebellion Against Brand Policy Motivation:** “Product care has been made challenging, which motivates me.”
- Aesthetics Motivation:** “The aesthetics motivate me.”
- Intrinsic Motivation:** “My sustainable personality motivates me.”
- Irreplaceability Motivation:** “Emotional attachment to the TOG motivates me.”

Only the “Rebellion Against Brand Policy” factor seems less motivational, as it has a median of 2.00 (Untrue). The consistency in the found median values across most factors suggests that these motivational aspects are generally perceived as equally influential by participants in their decision to care for their technical outdoor garments.

When we view our bar graphs, the Functionality factor stands out. It has been indicated as influential by 53.0%, and very influential by 41.0% of the respondents (n=134).

However, some motivational factors have been answered negatively by respondents, while their medians indicate a positive influence. There’s a notable division in opinions, with some people not finding it motivational at all. For some respondents, factors related to identity (35.8% Untrue, n=134) and irreplaceability (31.3% Untrue, n=134) do not appear to be strong motivators for TOG product care.

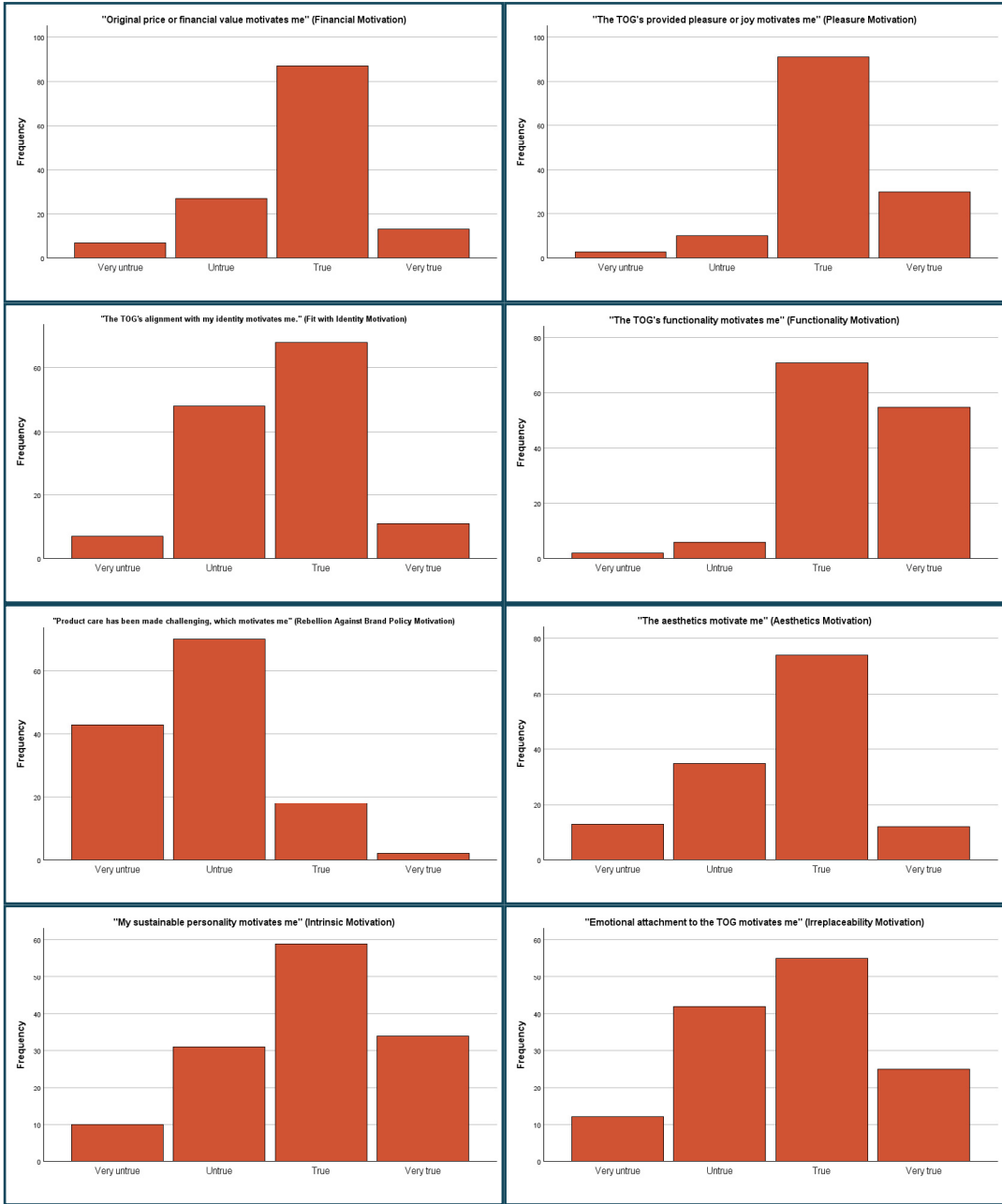


Figure 28. Motivation factor bar graphs

Ability Factors

Knowledge & Skills, Time & Effort, and Lack of Tools all have a median of 3.00 (True), suggesting that participants think that these factors make product care of TOG difficult. This indicates that lacking knowledge about TOG product care, time/energy consuming procedures, and not having the right tools could be significant barriers to TOG product care.

Ability Factor Statistics					
		Knowledge & Skills	Time & Effort	Lack of Tools	Lack of Repairability
N	Valid	132	133	133	132
	Missing	2	1	1	2
Median		3,00	3,00	3,00	2,00
Mode		3	3	3	2

Figure 30. Ability factor median table

The consistency in responses (median 3.00) for the first three factors indicates that these are equally challenging aspects of garment maintenance for the respondents. The lower score for lack of reparability suggest that people are aware that TOG need product care.

For the ability factors that have a median score of 3.00, there are also high frequencies in Untrue scores. Our sample is divided between people that experience these factors to be a barrier and those that do not. Still, a higher frequency of participants report experiencing ability factors as barriers to TOG product care.

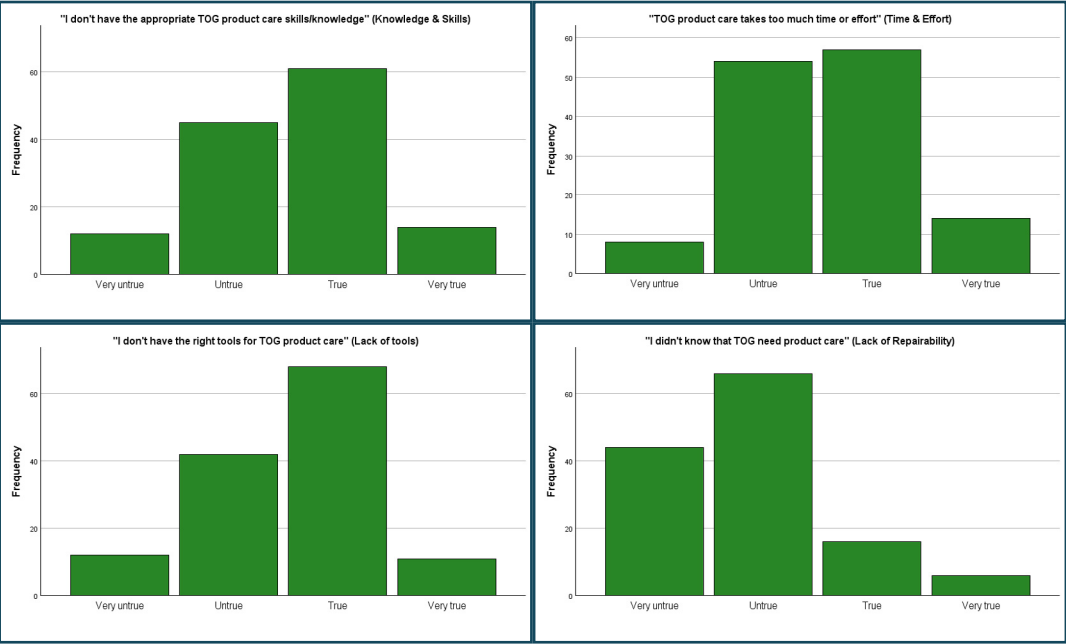


Figure 31. Ability factor bar graphs

Trigger Factors

Appearance and Previous Experience Triggers seem to be the most influential factors in triggering TOG product care with a median of 3.00. This means that people commonly experience a change in appearance or previous experiences that they had with TOG product care as effective triggers.

Ability Factor Statistics					
		Knowledge & Skills	Time & Effort	Lack of Tools	Lack of Repairability
N	Valid	132	133	133	132
	Missing	2	1	1	2
Median		3,00	3,00	3,00	2,00
Mode		3	3	3	2

Figure 32. Trigger factor median table

Time-based schedules, social influences, and challenging maintenance procedures were rated as less influential triggers (m = 2.00). This suggests that regular maintenance schedules, others’ opinions about garment cleanliness, and complex care procedures do not effectively prompt TOG care..

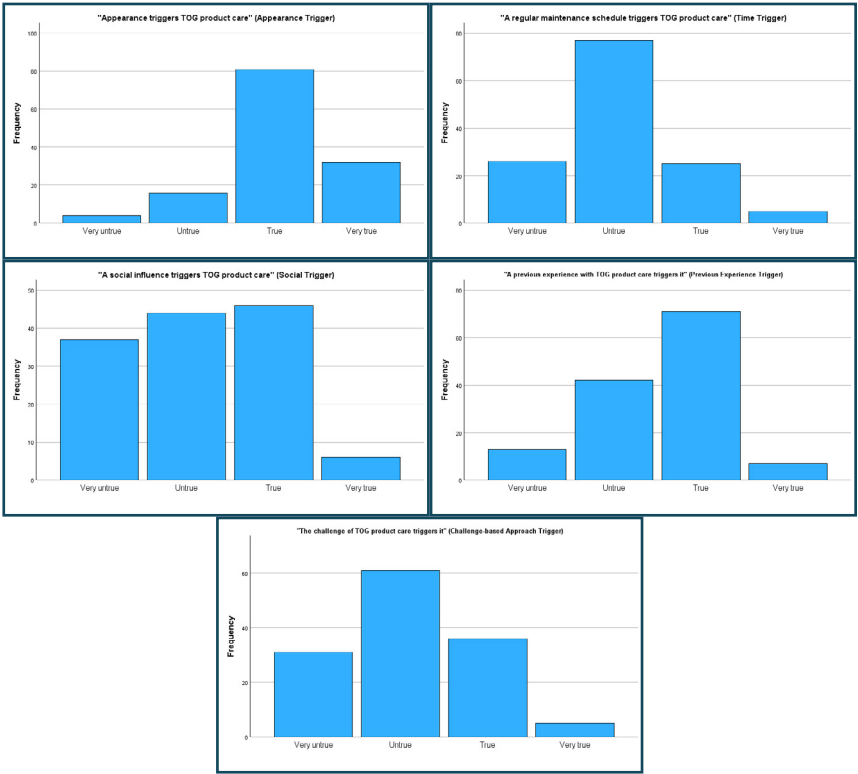


Figure 33. Trigger factor bar graphs

6.3.3. Correlation Analysis

To determine if there are statistically significant relations between the collected variables, we ran Spearman correlation tests.

Ability - Product Care Participation

According to our table, we can assume that there is a significant, positive, moderate correlation between the Knowledge & Skills (Spearman's r = 0.384, p < 0.001), Time & Effort (Spearman's r = 0.379, p < 0.001), Lack of Tools (Spearman's r = 0.300, p < 0.001), and participation in product care. Examining the scatterplot, we can infer that for the Knowledge & Skills factor, for example, the less knowledge someone possesses, the less likely they are to maintain their TOG.

Correlations						
Spearman's rho	Product Care Participation		Product Care Participation	Knowledge & Skills	Time & Effort	Lack of Tools
		Correlation Coefficient	1,000	,384**	,379**	,300**
		Sig. (2-tailed)	.	<,001	<,001	<,001
		N	132	130	131	131
		Correlation Coefficient	,384**	1,000	,459**	,601**
Knowledge & Skills		Sig. (2-tailed)	<,001	.	<,001	<,001
		N	130	132	132	132
		Correlation Coefficient	,379**	,459**	1,000	,464**
Time & Effort		Sig. (2-tailed)	<,001	<,001	.	<,001
		N	131	132	133	133
		Correlation Coefficient	,300**	,601**	,464**	1,000
Lack of Tools		Sig. (2-tailed)	<,001	<,001	<,001	.
		N	131	132	133	133
		Correlation Coefficient				

** . Correlation is significant at the 0.01 level (2-tailed).

Figure 34. Ability - product care participation Spearman rho table

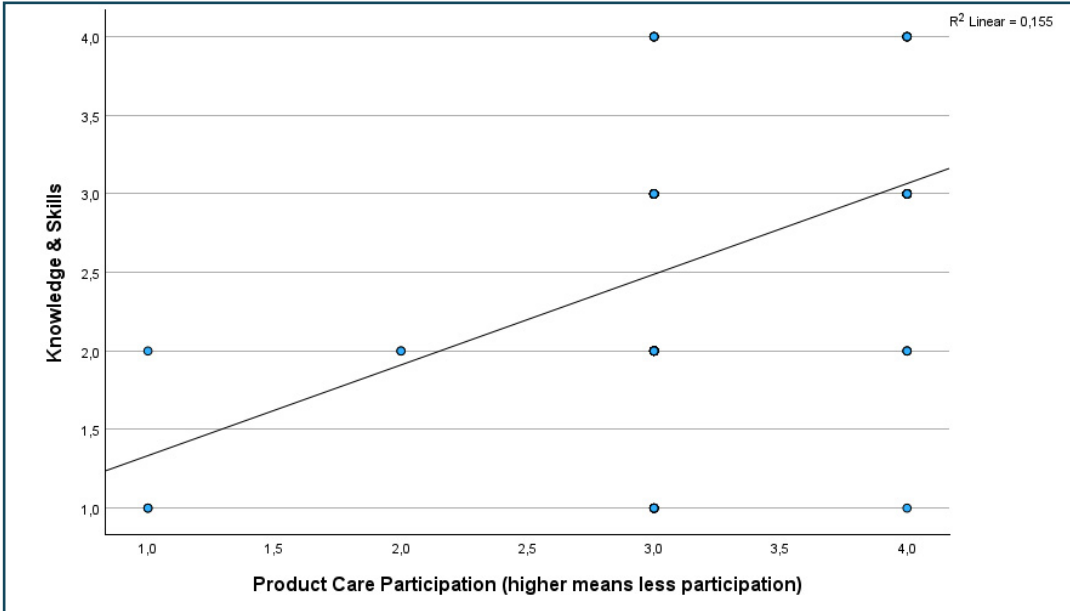


Figure 35. Ability - product care participation scatterplot

Product Care Experience - Product Care Participation

According to our table, we can assume that there is a significant, negative, moderate correlation (Spearman's r = -0.432, p < 0.001). When also looking at the scatterplot, we can estimate that those who are more experienced in TOG product care, are more likely to maintain their TOG.

Correlations				
Spearman's rho	Product Care Participation		Product Care Participation	Product Care Experience
		Correlation Coefficient	1,000	-,432**
		Sig. (2-tailed)	.	<,001
		N	132	132
		Correlation Coefficient	-,432**	1,000
Product Care Experience		Sig. (2-tailed)	<,001	.
		N	132	134
		Correlation Coefficient		

** . Correlation is significant at the 0.01 level (2-tailed).

Figure 36. Product care experience - participation Spearman rho table

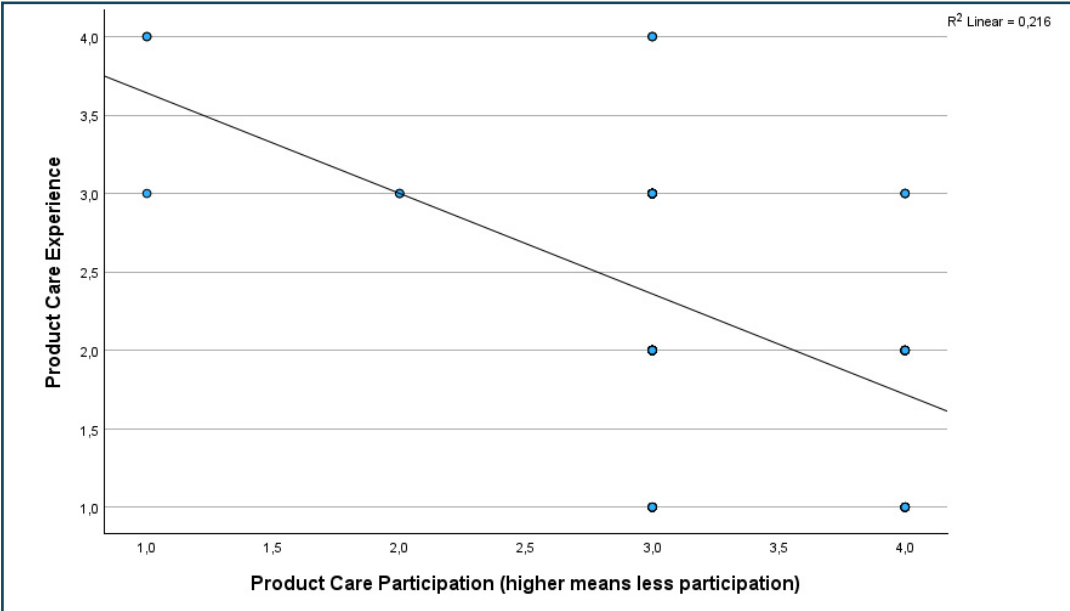


Figure 37. Product care experience - participation scatterplot

6.4. Result Summary

6.4.1. Product Care Participation

- People participate in TOG product care, but still do this only a few times a year, some participants never maintain their TOG.
- There is a discrepancy between TOG use frequency and maintenance frequency. 45 out of 97 Participants that use their TOG multiple times a week only maintain a few times a year. 11 out of 29 that use their TOG weekly never maintain them.

6.4.2. Product Care Behaviour

- Care labels are the primary source of product care information.
- Washing machines and drying racks are the most frequently used product care tools, with specialized TOG detergent being popular.
- A majority of respondents use alternative product care tools, with wash-in products being the most popular. Some people use normal detergent and some even use fabric softeners, two products that are discouraged to use for TOG.
- Self-care is the predominant approach to product care, but professional and family/ friend help also occurs.

6.4.3. Owned TOG Types

- Waterproof jackets are the most common type of TOG owned by respondents.
- Water-repellent jackets, waterproof pants, and both down jackets and pants were also commonly owned among respondents.

6.4.4. FBM Factors

- Most participants say that they are motivated by most motivational factors. Functionality is the most influential out of all factors, and Rebellion Against Brand Policy is the least influential.
- Participants find Appearance and Previous Experience the most influential triggers for TOG product care.
- Knowledge & Skills, Time & Effort, and Lack of Tools are perceived as the most significant barriers to TOG product care.

6.4.5. Correlation Analyses

- A moderate positive correlation exists between the lack of knowledge, time, and tools and participation in product care. This suggests that people are less likely to maintain their TOG when they lack knowledge, tools, or time and energy.
- There is a moderate negative correlation between product care experience and product care participation. This indicates that more experienced individuals are more likely to maintain their TOG regularly.

6.5. Conclusion

In conclusion, this analysis of Technical Outdoor Garment (TOG) product care behaviour reveals several insights when viewed through the lens of the Ackermann et al. (2018) adapted Fogg Behavior Model (FBM). The model suggests that, ideally for a behavior to occur, three elements must converge: Motivation, Ability, and Triggers. Our findings impose the following according to the framework:

- Motivation: Most participants report being motivated to maintain their TOG, with functionality being the most influential factor.
- Triggers: Appearance changes and previous positive experiences emerge as the most effective triggers for product care.
- Ability: Despite high motivation and existing triggers, significant barriers to consistent care exist, primarily in the form of lack of knowledge and skills, time and energy constraints, and insufficient tools. These barriers directly correspond to the 'Ability' factor in the FBM, suggesting that low ability is the bottleneck that prevents users from maintaining their TOG.

The discrepancy between TOG use frequency and maintenance frequency highlights a critical gap where the convergence of motivation, ability, and triggers is not occurring, causing people to inconsistently maintain their TOG. Furthermore, the analysis indicates that more experienced individuals are more likely to maintain their TOG regularly, suggesting that as ability increases, the likelihood of the desired behaviour also increases.

These findings, viewed through the adapted FBM model, suggest that while motivation and some triggers are present, the primary barrier to consistent TOG care lies in the 'Ability' component. Our design has to focus on this. Enhancing user knowledge, developing time-efficient care methods, and ensuring access to appropriate tools with our design could increase the likelihood of consistent TOG care behavior

6.6. Discussion

This research has some limitations that should be considered when interpreting the results. First, the study used purposive sampling with 134 respondents. This relatively small sample size may limit the generalization of the findings to the broader population of TOG users. This is because we could not use Bever's newsletter to distribute the survey. The mailing schedule for the newsletter was already fully booked, and an open spot for the survey was too far in the future to still adhere to the planning of the project.

Second, the study was conducted in only two specific Bever store locations; The Hague and Leidschendam. This may not represent the entire Bever consumer base across the Netherlands. The time frame of the project allowed us to visit only two stores on three consequent days. In an ideal circumstance we would have visited the stores in each province that Bever is operating in, or we would have preferred to use the newsletter to distribute the survey. This would give us a larger and more diverse audience, which would lead to more generalizable results.

The survey relies on self-reported behaviour and attitudes towards TOG product care. We asked people to answer as truthfully as possible, but it is possible for the participants to have experienced recall bias or social desirability bias. This leads us to the following limitation: the study asked about TOG use in the past 12 months. This approach fails to capture long-term patterns of use and care. A longitudinal study observing people's TOG product care behavior over an extended period would have provided more comprehensive insights. Unfortunately this was not possible due to the time-frame of the project.

Phase 2: Conceptualizing Solutions

7. Ideation

After drawing conclusions from our research, we had a starting point for our design process that was based on scientific research and established theory. This chapter explains the ideation phase of the project.

7.1. Design Goal Redefinition

The research findings underscore the importance of enhancing user knowledge, developing time-efficient care methods, and ensuring access to appropriate tools. By addressing these aspects, we can work towards increasing consistent consumer participation in TOG product care, ultimately extending the lifespan and performance of these specialized garments. Thus, to reiterate our previous design goal:

“To increase more consistent Bever consumer participation in TOG product care, we need to provide easily accessible information, reduce the required time and effort, and ensure that users have the appropriate tools for the act.”

This design goal is split-up in sub-goals that are integral to reach it:

- **Sub-goal 1:** Knowledge & Skills have to be improved
- **Sub-goal 2:** Lower the time and effort required for TOG care
- **Sub-goal 3:** Provide the appropriate tools for TOG care

This is the second iteration of the design. At the end of this chapter, it is redefined after crucial feedback by Bever.

7.2. Action Points for Ideation

Our defined goals were translated to action points to use for our ideation process:

- - Enhance users' knowledge and skills related to TOG care.
 - Educate about proper cleaning products, emphasizing the use of specialized TOG detergents and discouraging the use of inappropriate product care tools.
- - Develop time-efficient, easy to use TOG care methods.
- - Provide the necessary tools for TOG care.
- - Emphasize the functionality benefits of proper care.
- - Leverage appearance-based triggers and previous positive care experiences to stimulate TOG care.
- - Tailor care strategies to different types of TOG, with a focus on waterproof jackets.
- - Create something that is tailored to an individual, because self-care is most prominent.
- - Use circular or sustainable materials for our design.
- - Promote the use of sustainable detergents.

These actions points formed the first iteration of our list of requirements. It can be viewed in appendix C.

7.3. Ideation Process

Our ideation process consisted of with mindmap brainstorming in which we tried to find patterns or insights that intrigued us according to our action points. After this, we tried to translate that into ideas through exploratory sketching.

In figure 38, excerpts of our sketchbook portraying our ideation process can be seen, along with early concept sketches.

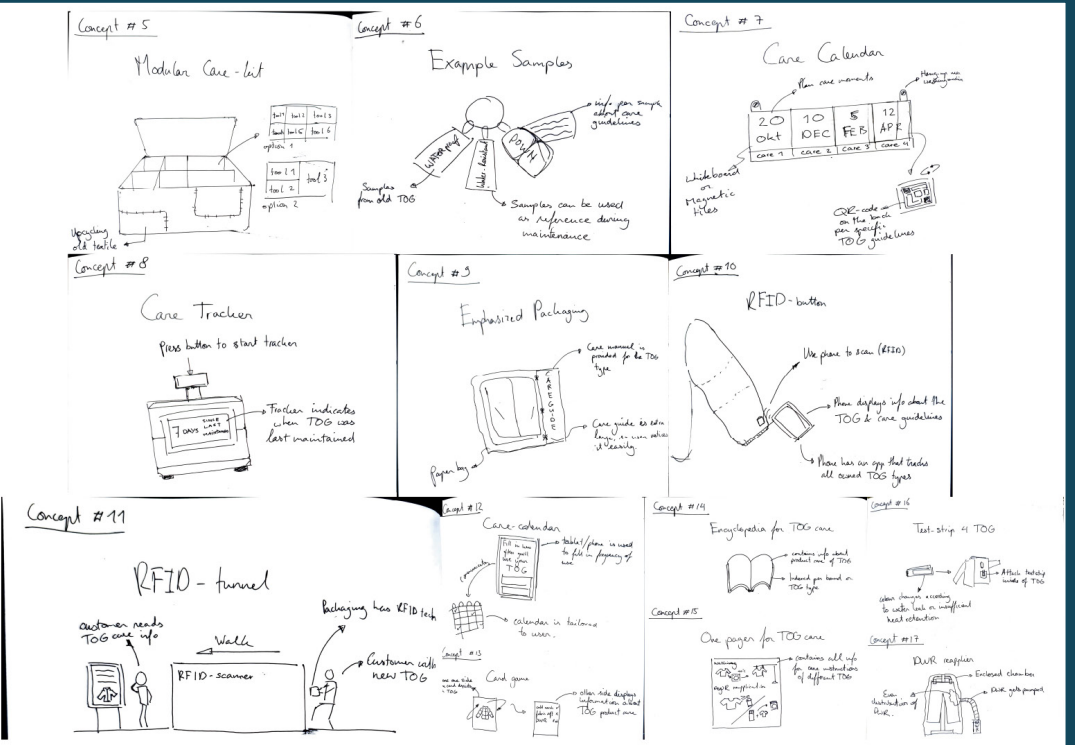
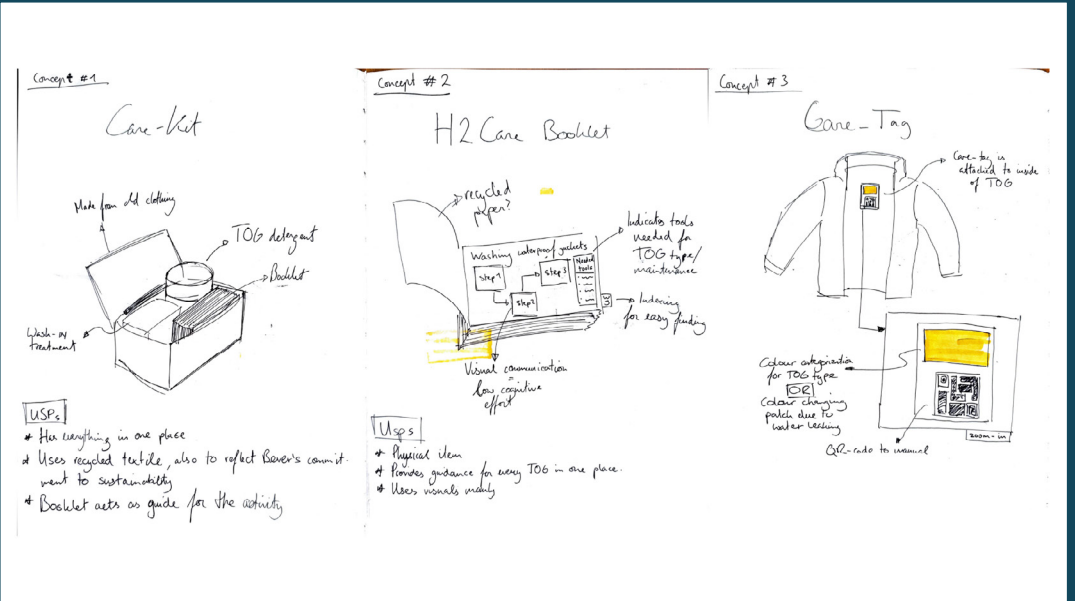
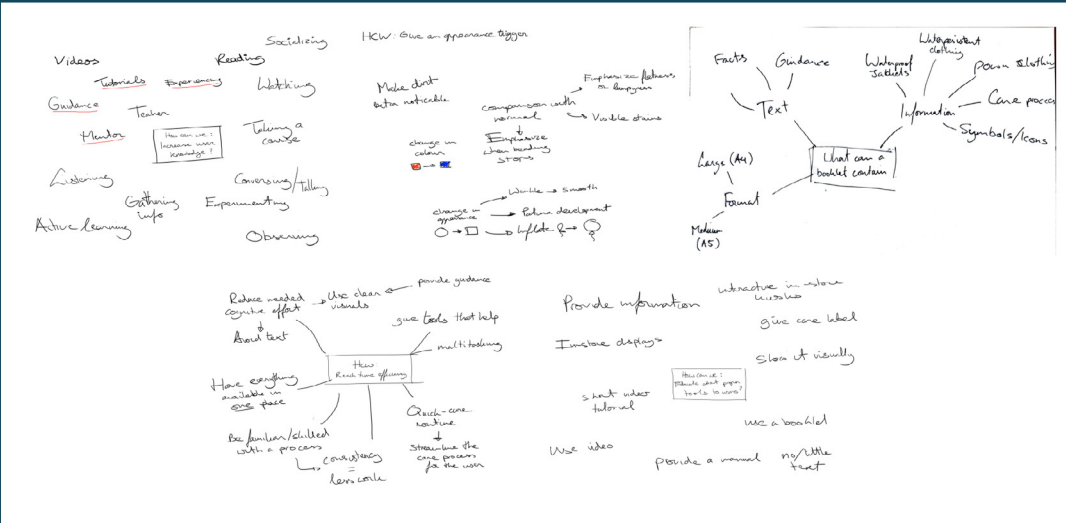


Figure 38. Mindmaps and sketches

7.4. Sketches to Concepts

Three ideas were chosen to develop further into concepts to present to Bever. These ideas were distilled to three chosen concepts that intrigued us most according to our defined action points. These are as follows:

Sherpa Bag (concept #1)

An all-in-one toolkit for properly maintaining your TOG, inspired by first-aid kits. Contains all essentials for TOG care: detergent, wash-in treatment, an instruction booklet, down fluff balls, etc.

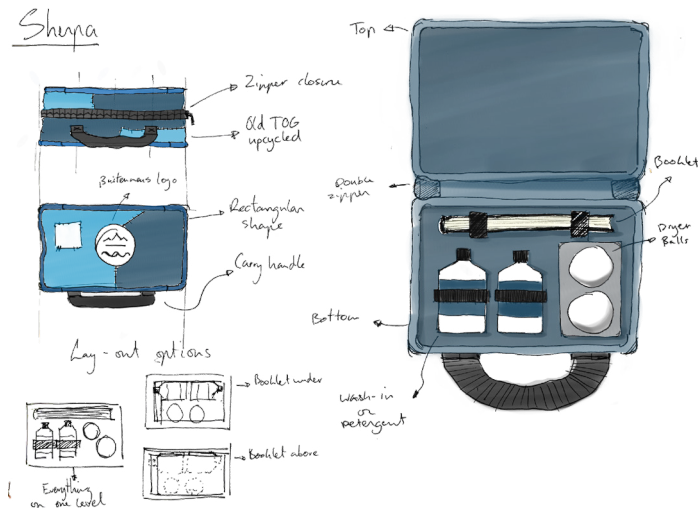


Figure 39. Sherpa Bag concept sketch

Care Booklet (concept #2)

An indexed, visual instruction manual about properly maintaining TOG. Has a small size factor, made for quick and easy access during maintenance.

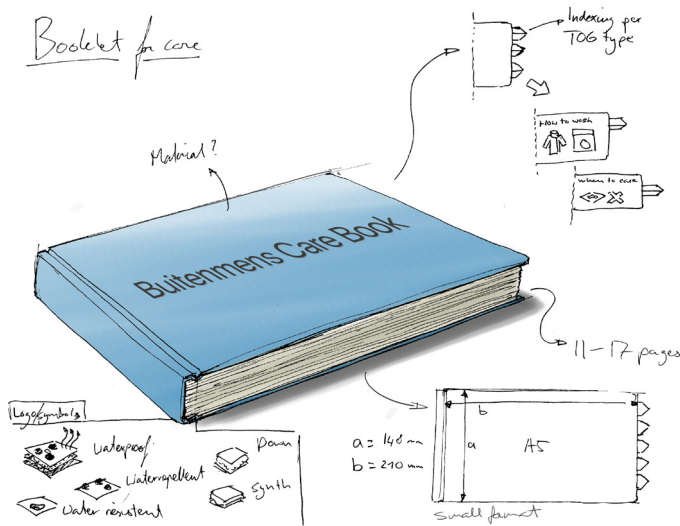


Figure 40. Care Booklet concept sketch

Care Mark (concept #3)

A tag that gets attached to the inside of a TOG. Contains a QR code or alternative digital gateway to care guidelines on your phone. Also has a colour patch that is reactive to either moisture or heat.

Care Mark Concept

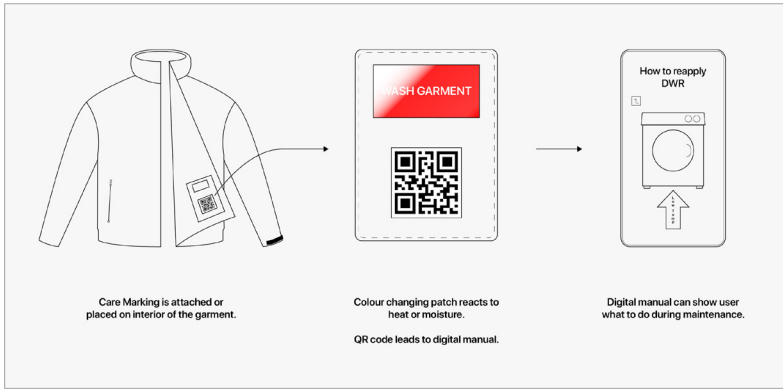


Figure 41.Care Mark concept sketch

		Sub-goal 1: Increase Knowledge & Skills	Sub-goal 2: Lower Time & Effort	Sub-goal 3: Provide Tools
★	Sherpa Bag	Provides information through booklet and an object that facilitates practice.	Everything for the process available in one place.	The kit contains the various tools one would need.
	Booklet	Booklet provides information with visual elements. Facilitates TOG care.	Clear, tangible support tool during the process.	Tools not provided.
	Care Mark	QR/Rfid provides information through user's phone.	Clear, digital support tool during the process.	Tools not provided.

Figure 42. Concept choice table

7.5. Choosing Definitive Concept

We want our design to reach every sub-goal that we established. To have a clear overview of how well each concept fulfills our sub-goals, we validated our concepts against these criteria. The table above (figure 42.) provides an overview of how each concept addresses our established sub-goals. This validation helped us understand the strengths and limitations of each concept.

According to the validation, the Sherpa Bag comes out on top. This was also the concept that we suggested Bever to continue with for this design project.

However, based on Bever’s feedback about missing triggers, the project direction shifted away from the Sherpa Bag concept to address their specific concerns about invisible contaminants in TOG maintenance. We discuss this in the next section.

7.6. Design Goal Redefinition after Bever’s Feedback

After presenting our research data and concepts to Bever, they shared crucial feedback for our concept selection. Based on experiences from their product guarantee department, they explained that customers often lack awareness of an important trigger for product care: invisible contaminants. Many customers are unaware of the influence of invisible contaminants on TOG performance. Bever believes highlighting these invisible contaminants could trigger users to perform maintenance before their TOG lose functionality completely. Hence, Bever has the most interest in pursuing the Care Mark concept, since it directly tackles this issue.

While this feedback added complexity to our concept selection process, it also made us realize that we overlooked a part of our initial problem statement (see introduction chapter). Also because our research suggested no apparent problem with missing triggers. Based on Bever’s feedback, we refined our design goal:

To increase consistent consumer participation in TOG product care by making invisible contaminants visible as a trigger, while providing easily accessible information, reducing required time and effort, and ensuring users have appropriate tools for maintenance.

This iteration of our design goal has an additional sub-goal that focuses on making invisible contaminants visible as a trigger for TOG product care. So now our sub-goals are:

1. **Sub-goal 1:** Knowledge & Skills of TOG care have to be improved.
2. **Sub-goal 2:** Lower the time and effort required for TOG care.
3. **Sub-goal 3:** Provide the appropriate tools for TOG care.
4. **Sub-goal 4 (new):** Make invisible contaminants in TOG visible to trigger people to perform TOG care.

7.7. Merging Concepts: Three Birds with One Stone

As we explained with our concept choice table, the Sherpa Bag was preferred to continue with. Unfortunately the concept does not fulfill Bever’s key need of emphasizing invisible contaminants to trigger product care. However, because the Sherpa is based on the idea of being an all-in-one kit for TOG product care (and already contained the Booklet concept), the Care Marking concept could be added as one of the components of the Sherpa.

This combination of the concepts ensures that we can reach our proposed sub-goals based on our research, and fulfill Bever’s wish. This combination of concepts will continue under one name: **The Buitenmens Sherpa**

7.8. Limitations & Recommendations

Continuing with three concepts instead of one limits us in how developed each concept will be due to this thesis’ timeframe. The three concepts will have different technology readiness levels (TRL).

The Booklet and Sherpa Bag are expected to be developed to TRL 5 or 6: we can easily create a high fidelity prototypes, the Booklet can be printed and we can sew the Sherpa Bag to validate these concepts in a simulated or real-world condition.

On the other hand, due to the complexity of how the Care Mark concept will probably work, we expect it to be able to reach TRL 3 or 4. It would involve developing a reactive textile material that can make invisible contaminants visible. This is complex technology and would require significant research and development to create a reliable color-changing material that effectively detects contaminants and triggers care.

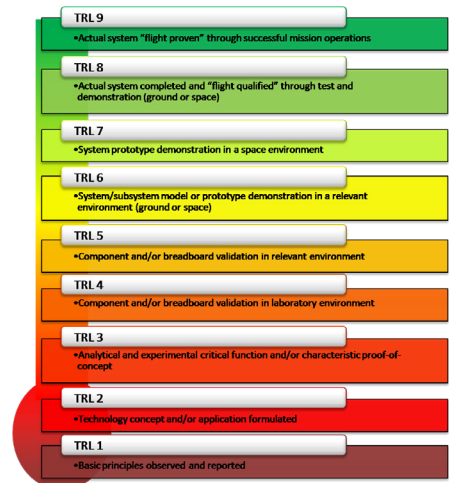


Figure 43. Technology readiness levels

Looking back, we dismissed the “alerting” aspect of our initial problem statement (see introduction chapter) after our research, because we did not notice any problems with trigger factors. If we had leveraged Bever’s assistance during the ideation process, by including employees in a focus group or creative facilitation session we could have been reminded about the importance of making contaminants visible as a trigger earlier.

7.9. The Buitenmens Sherpa Requirements

After the ideation phase we had a new direction for our design. Our updated List of Requirements reflects that new direction, and adds more developed criteria since we have a clearer direction. The original list can be viewed in appendix C.

7.9.1. Research conclusion relevant criteria

- The Buitenmens Sherpa acts as a facilitator for TOG product care, due to low ability factors
- The Buitenmens Sherpa compensates for the low ability factors to ensure that all three FBM factors are sufficient to activate participation in TOG product care:
 - The Buitenmens Sherpa enhances the user’s knowledge and skills about TOG care by providing information about the process (Knowledge & Skills)
 - The Buitenmens Sherpa provides the proper tools for TOG product care, and instructions on how to use them (Lack of Tools + Knowledge & Skills)
 - The Buitenmens Sherpa is easy to understand and use by the average Bever consumer (Time & Effort)
 - The Buitenmens Sherpa is time-efficient (Time & Effort)

- The Buitenmens Sherpa is supposed to be used by the user in their homes
- The solution is tailored to all TOG types

7.9.2. Concept Component criteria

The Buitenmens Sherpa is comprised of four components:

1. The Kit:
 - Efficiently contains all other components of the Buitenmens Sherpa
 - Neatly presents the tools to the user through a foldable construction
 - Allows for neat storage of tools.
2. The TOG Care Booklet:
 - The booklet provides information about the TOG care processes
 - The booklet provides information about proper tools and how they are used
 - The booklet has an A5 size to provide an easy to handle item during maintenance
3. The Care Mark
 - The Care Mark is installed on the interior of a garment
 - The Care Mark utilizes a reactive textile to make contaminants visible
 - The Care Mark utilizes a reactive textile to trigger product care
4. TOG detergent and wash-in treatment
 - These have to be from Bever’s Buitenmens care-product collection

7.9.3. Bever Criteria

- The Buitenmens Sherpa makes invisible contaminants visible to the user through the utilization of a reactive material
- The Buitenmens Sherpa needs to appeal to the average Bever consumer:
 - The Buitenmens Sherpa motivates the intrinsically sustainable Responsibles through sustainability aspects
 - The Buitenmens Sherpa caters to the Status Conscious by using sustainability as means of showing status
 - The Buitenmens Sherpa allows Developers to freely participate in product care
 - The Buitenmens Sherpa should be found desirable by Bever consumers
 - The Buitenmens Sherpa price should be similar to what Bever consumers are willing to pay
- The Buitenmens Sherpa needs to encompass the Best Services identity pillars of Bever:
 - Help consumers to enjoy their Bever products for longer by offering products and services that extend TOG lifetime

7.9.4. Circular Economy Criteria

- The Buitenmens Sherpa uses repurposed textiles for the kit component
- The Buitenmens Sherpa’s reactive tag uses non-synthetic means to achieve its reactivity
- The Buitenmens Sherpa assists in retaining value of owned TOG by encouraging and guiding product care
- The Buitenmens Sherpa contributes to extension of TOG lifetime by encouraging product care
- The Buitenmens Sherpa leverages the design for maintenance principle by providing the means to simplify TOG care

Phase 3: Developing & Evaluating



Figure 44. Cutting up an old TNF jacket

8. Design Development

Based on our research's presented lack of ability in our participants, the Buitenmens Sherpa has to be a facilitator for the product care process to instigate a behaviour (Fogg, 2009). It also has to provide a trigger for care by revealing invisible contaminants, according to Bever's wish. The Buitenmens Sherpa facilitates achieves this with its four components:

1. Product care tools (TOG detergent and TOG waterproofing) provide a means to maintain TOG
2. The Care Booklet provides information and guidance for proper care
3. The Care Mark presents a trigger for maintenance to the user, based on unveiling invisible contaminants
4. The Kit contains these items together in one, easily accessible container

These development of these components and their functions are explained in this chapter.

8.1. Design Inspirations

The Buitenmens Sherpa's components draw inspiration from existing products and solutions, which have formed the foundation for both their functionalities and designs.

8.1.1. Inspirations for The Kit

The Kit was inspired by first-aid kits and tool rolls. Just like these portable containers, it holds essential items accessibly and organized for the use context.



Figure 45. Examples of a first-aid kit (left) and a tool roll (right)
(TravelSafe, n.d.; Lewis & Lewis, 2022)

First-aid kits are designed to be compact yet comprehensive, containing all essentials for emergency medical care. Their compartmentalized interior facilitates quick access to specific items when needed. This was the inspiration for the form factor of the Kit, which influenced our initial Sherpa Bag concept as well.

Tool rolls used by mechanics and craftspeople also have individual pockets to organize tools, but what was intriguing about the tool roll was its rolling mechanism. A seamless movement/ action that creates easy access to tools after unrolling, and quick tidying up after rolling up. This translated to our design in a unfolding/folding construction.

Lastly, Bever's travel accessory category of their Buitenmens collection has a distinctive, upcycled look that specifically inspired the aesthetic of the Kit. The patchwork constructions not only create a unique aesthetic, but it also conveys Bever's commitment to sustainability. Since the Kit is made from textile, we can adopt this aesthetic to reflect the same distinctive, sustainable look by also upcycling old textile.



Figure 46. Example of a Buitenmens travel bag
(Bever, n.d.-a)

8.1.2. Inspirations for The Care Mark



Figure 47. Thermosensitive garments (Stone Island, n.d.)

Italian fashion brand Stone Island produces thermosensitive garments in their collection. These pieces are dyed with thermochromic pigments that respond to body heat, which creates unique patterns each time someone wears them. A fabric with this effect is enchanting and distinctive. It inspired us to think about how a colour changing characteristic could be used as a product care trigger. A more functional inspiration was already mentioned in section 5.4.

The toothbrush bristles with wear indicators that Oral-B offers change colours from usage. These bristles make it clear to the user when they have to replace their toothbrush, serving as a simple yet effective visual indicator. This same principle could be applied to the Care Mark, where a visual change could signal when maintenance is needed.

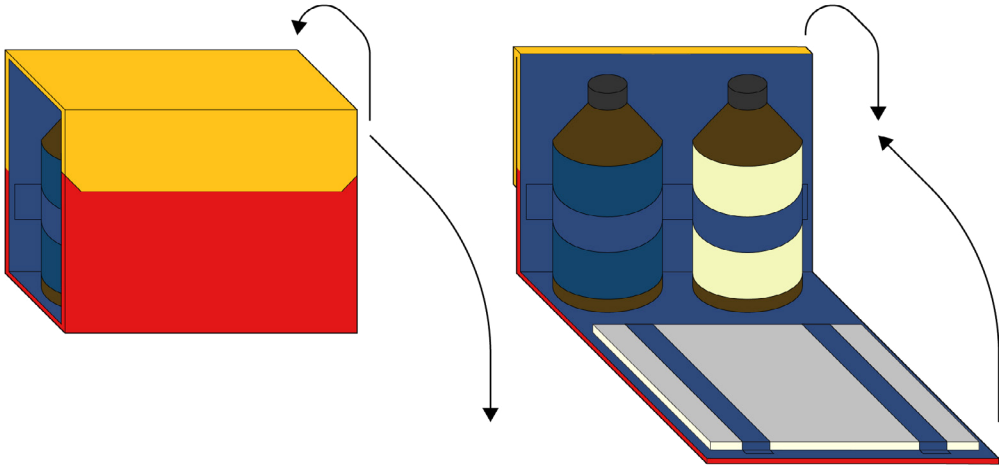


Figure 49. Rolling & unrolling the Kit

8.2. The Kit

The Kit functions as the vessel of our design. It contains all other components, and after unrolling it provides a neatly organized container to the user. It holds:

1. Buitenmens Sport Textile Wash
2. Buitenmens wash-in waterproofing.
3. The TOG Care Booklet.
4. The Care Mark (inside the Booklet).

The kit would be placed near the washing machine and tumble dryer of the user. Here, one can grab the Kit when they have to maintain a TOG, where it will neatly present all the tools for maintenance. The Kit is an object that not only provides the means for proper product care, but also delivers it in an appealing and easy to use package.

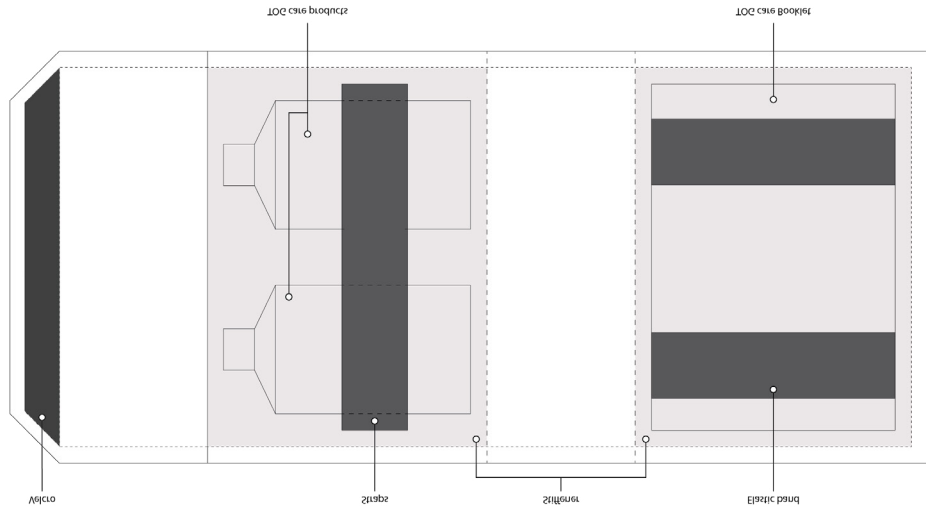


Figure 48. Schematic overview of the Kit

8.2.1. Prototyping & Evolution of the Kit

Prototyping the Kit was a constant cycle of evaluating and iterating that led to our final prototype. Figure 50. visualizes our process. We started with a lo-fi paper model, then a lo-fi textile model to check dimensions, and eventually created the final high-fi prototype.

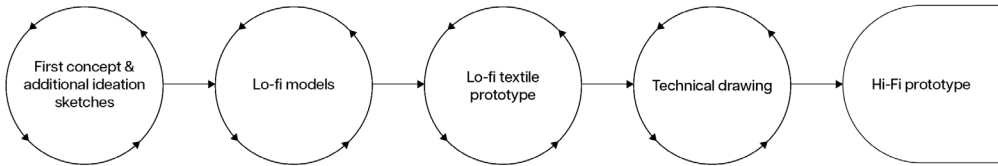


Figure 50. The Kit iterations

During the ideation stage, the Kit came about as an idea to provide an all-in-one package for product care. Inspiration was taken from first-aid kits and tool rolls, and initially the same construction and form was mimicked. This evolved into a different direction because we realized that the use-context of a first-aid kit and the Kit are different. The closed construction of a first-aid kit was not needed for the Sherpa bag, because our design is used indoors.

Thus, the design does not have to provide protection to its contents, nor does the Sherpa Bag user transport it over long distances. This made us opt for an open construction that does not use a zipper, and more closely resembles a tool roll. Essentially the open construction resulted in simplicity and cost-effectiveness. Less material is used and the assembly time of the Kit should be lower because of this.



Figure 51. From lo-fi to hi-fi



Figure 52. Excerpts from prototyping

8.2.2. Resource Cycle of the Kit

Bever already collects used garments from customers and upcycles them into new clothing and accessories for their Buitenmens collection. This existing resource cycle can be leveraged to manufacture the Sherpa Bag.

This approach gives the Kit an upcycled look that emphasizes Bever's commitment to sustainability and circular practices, while taking a sustainable approach to the materials of the design.

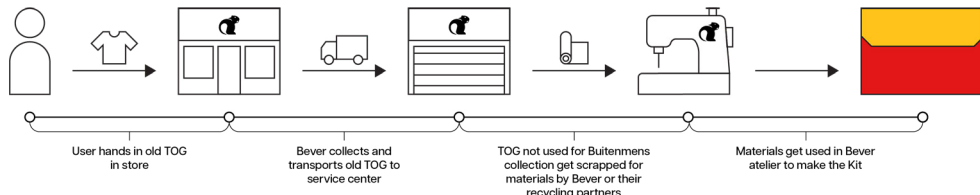


Figure 55. Resource cycle visualized

Bever's recycling partners can help in this process, just like for the Buitenmens collection. Moreover, when materials or parts from collected clothes are insufficient, these could be supplemented with materials from partners like Sympany or FastFeetGrinded, since they specialize in creating raw material from textile and footwear waste.

8.2.3. TOG Detergent & Wash-in Treatment

With the Buitenmens Sherpa we offer the products from Bever's own product line: The Buitenmens Care-products. Using Bever's own products to promote TOG care aligns perfectly with the company's ideals.



Figure 54. Bever's sustainability partners, including Sympany & FastFeetGrinded

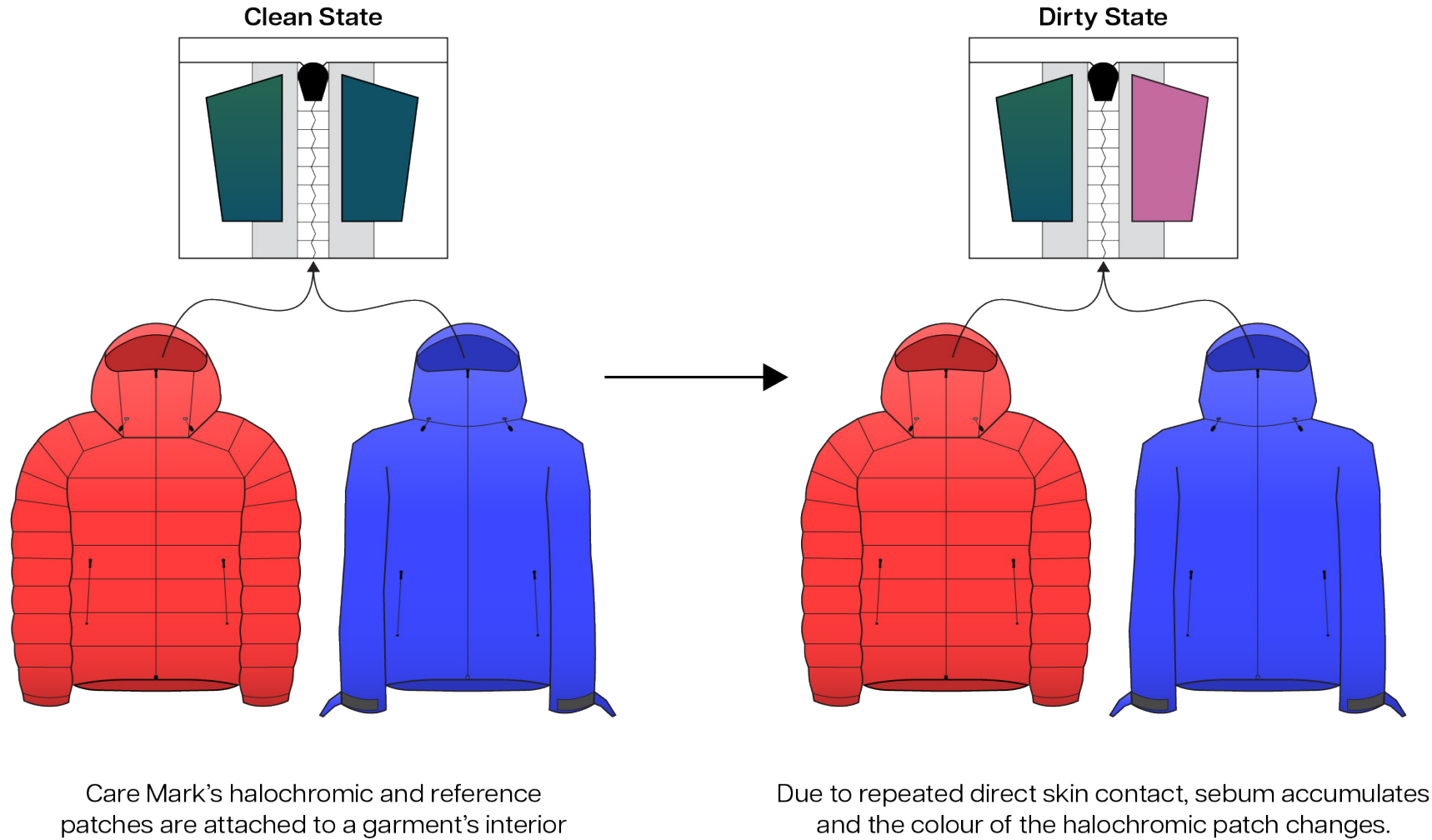


Figure 56. The Care Mark explained

8.3. The Care Mark

The Care Mark is a halochromic patch that changes colour based on the amount of sebum that accumulates in a TOG. The colour change serves as a visual trigger to help users know when their garment needs maintenance.

The Care Mark consists of two patches that the user sticks on the interior of a garment: a halochromic patch and a reference patch. The halochromic patch actually changes colour. The reference patch allows the user to check how dirty their garment is, without needing to check the Booklet.

Lastly, the halochromic patch is removable from the garment with Velcro. This is to avoid false positives that can occur when reapplying a DWR treatment (more about this is explained further in the chapter).

8.4. Developing the Care Mark

From various papers, we found two potential reactive textiles that could react to invisible contaminants in TOG. This section explains how we came to the definitive reactive textile for the component. We first explored what the invisible contaminants entail.

8.4.1. What are Invisible Contaminants?

Contaminants that can accumulate in a TOG can come from two sources: the wearer and the environment. Contaminants from the wearer originate from sweat and the skin. The skin secretes sebum, a greasy, acidic substance that protects and hydrates the skin, but it can clog the pores of waterproof garments and degrade DWR coatings, consequently reducing both breathability and water repellency. Sweat can promote the growth of bacteria, both on the body and in clothing. The environment can contaminate a TOG through particles from mud, dirt, dust, etc.

The presence of these contaminants can mean that a TOG has been worn for a long time, or that it has been used intensively. The contaminants also can hamper the functionalities of TOG. Therefore, we require a material that can visibly indicate the presence of these contaminants to the user, serving as a prompt for necessary product care.

8.4.2. Halochromic Textiles

Halochromic textiles are textiles that are treated with halochromic dyes. Halochromism refers to colour changing properties due to the external stimulus of a variation in pH level. Halochromic dyes have been applied in various contexts, like in pH indicators that are often used in laboratories (Rumah et al., 2023). Textiles can be made into halochromic materials through dyeing with a halochromic dye. According to Leite et al. (2023), cotton dyeing and polyester screen printing are viable ways to create halochromic textiles.

Some plants contain anthocyanin, a halochromic pigment. Rumah et al. (2023) have explored extracting halochromic dyes from plants as an alternative to synthetic dyes. According to their research, various common houseplants - like the Cordyline fruticosa - were suitable to extract halochromic dye from. Moreover, red cabbage is also known to produce halochromic dye.

Reaction with contaminants

Halochromic textiles could be applicable to indicate a variation in pH caused by human contaminants in a TOG. A prominent contaminant that can accumulate in clothing is sebum, which known to have a pH between 4.5 and 6.0 (Lovász et al., 2017). When a halochromic textile inside of a TOG makes repeated contact with the wearer's skin, sebum could accumulate on that halochromic textile. The occurring colour change then indicates that a TOG is contaminated and should be washed.

8.4.3. Animated Linen

According to a study by Walters et al. (2024), linen can be used to create a hygromorphic textile. This is an animated material that reacts to the external stimulus of moisture or water. The paper explains that due to the structure of linen, linen swells significantly when it absorbs water molecules. When linen yarn is spun with a high-twist, meaning that it has been spun more than is needed to keep the structural integrity of the yarn, energy is stored within the material. This energy wants to escape, which can happen when the linen absorbs water, thus creating a hygromorphic material.

Reaction with contaminants

When a TOG with a breathable membrane is used excessively, its pores get clogged by contaminants. This deteriorates the breathability of such garments. Animated Linen has potential to indicate when too much moisture is being trapped inside of a TOG as a result of this loss of breathability. For example: excessive moisture causes a linen patch inside of a TOG to pleat or crumple. This would indicate the user that their TOG is dirty and in need of product care.

8.4.4. Choosing A Reactive Textile

We found two promising materials to integrate in the Care Mark. Both materials react to external stimuli associated with TOG contamination, exhibit reversible reactivity, and can be produced using accessible materials and methods. After discussing which material is better to incorporate in our design with our supervisors, we came to the conclusion to continue with halochromic textiles because of the following:

The shape change of animated linen disappears after a few hours, depending on how much moisture is absorbed. So, a user could miss the trigger if they are not actively paying attention after each wear. Animated linen could also change its shape and show a false positive after just one wear. Animated linen seems too sensitive to moisture to consider for our context. However, what withholds us most from using this material is because it would only be applicable to TOG with breathable characteristics. This means that TOG without breathable properties, such as down-fill garments, would not be suitable for animated linen.

8.4.5. Exploring Halochromism

From my supervisor Stefano we received three fabric samples that were used in a previous project. These fabric samples were originally dyed with red cabbages, so the anthocyanin of the vegetables supposedly should create a halochromic textile. Leite et al. (2023), moreover successfully proved that fabric is a feasible medium for a halochromic sensor after applying halochromic dye with a stamp.

The samples we received consisted of two purple samples and one pink sample. According to the spectrum of anthocyanin, the pigment has a distinct colour per pH level. This means that the purple samples have a pH of 6-7 and the pink sample has a pH of around 3-4.

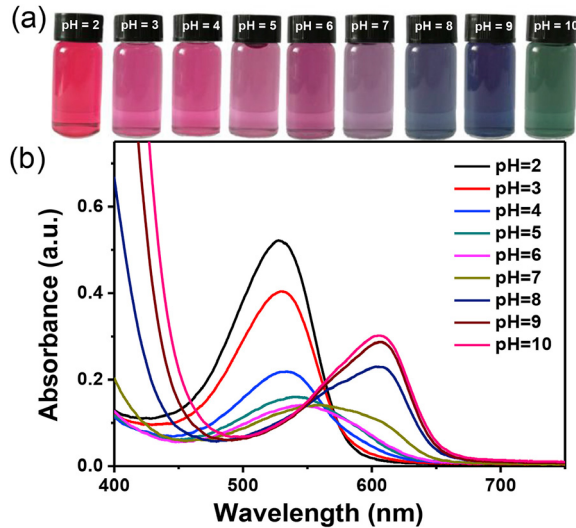


Figure 60. Colours per pH level of Anthocyanin (Tang et al., 2019)

One purple sample and one pink sample were consequently dipped in solutions that had an opposite pH, lime juice for the purple sample and a baking soda solution for the pink sample. The remaining purple sample was used as a reference.

Both samples showed halochromic behaviour, showing us that the anthocyanin is still active in the fabric fibers, like (Leite et al., 2023) argued in their research. Thus, dye extracted from red cabbage should be usable to create a halochromic fabric sensor.



Figure 58. Samples before and after colour change. Fabricated by Rebekka Groeneveld and dyed by Stefano Parisi, IDE TU Delft.



Figure 59. Samples portraying halochromism when dipped in alkaline (left) and acidic (right) solutions.

8.4.6. The Colour Change Cycle

According to the workings of halochromic dye and the nature of sebum, the Care Mark is supposed to go through a colour change cycle during the use of a TOG. This cycle is explained through the visual (figure 61.).

We hypothesize that the amount of sebum accumulated in a TOG correlates with how much the garment has been worn. When a TOG is worn frequently or for extended periods, there is more skin contact, leading to greater sebum accumulation. This accumulated sebum gradually changes the pH level of the halochromic textile, resulting in a more pronounced color change. Therefore, the colour state could serve as an indicator of both wear frequency and the need for maintenance - the more dramatic the color shift from the clean state, the more urgent the need for product care.

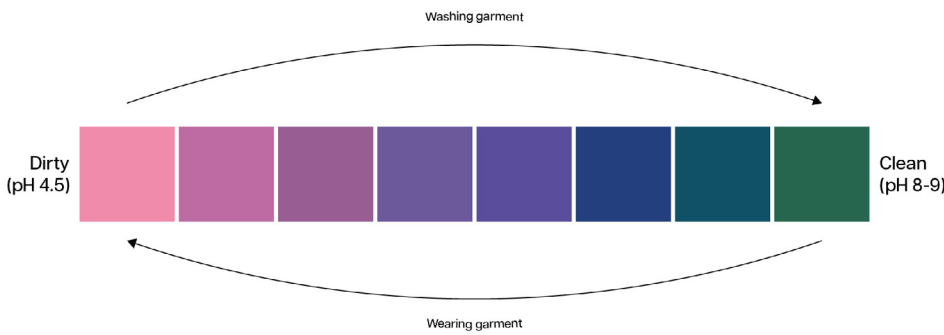


Figure 61. Care Booklet concept sketch

Clean State (pH = 8-9)

This blue-green hue is the state in which the customer receives their Care Mark. According to the colour spectrum of anthocyanin, this pH refers to an slightly alkaline pH. The reason for picking this as the clean state of the Care Mark, is because of the pH of the Buitenmens Care-products.

We consulted Johannes van Overmeeren, the senior product development engineer at OrganoClick. Which is the company that cooperates with Bever for the manufacturing of these products. He explains that about the specifics of these products, he stated that the Sport Textile Wash products are mildly alkaline (pH ~9). This means that the pH of a TOG after washing would have a similar pH.

Dirty State (pH = 4.5)

Our sebaceous glands secrete sebum, a substance that contains acids and lipids that create the acid mantle. This acid mantle is an important component our skin's first line of defense against bacteria and viruses. Sebum has a slightly acidic nature from around 4.5-6.0 pH.

This sebum is also the reason that white clothing turns yellow or greasy in specific places of the garment. To give an example, a common part of a T-shirt that turns yellow when well-worn is the neckline, since this part makes frequent contact with the skin.

Accumulation of sebum would lower the pH of the Care Mark, changing the colour to the lower pH part of the anthocyanin's colour spectrum.

Post DWR State (pH = 3)

Johannes van Overmeeren also told us that the Textile Waterproofing products are mildly acidic (pH ~3). The acidity of this product could create a false positive after reimpregnating a garment, which is to be avoided to prevent confusion. This brings us to the attention that the Care Mark has to be removable in order to prevent this false positive

Fortunately, reapplication of the DWR does not happen as common as washing or drying TOG, so removing the Care Mark does not have to be done during each maintenance session.

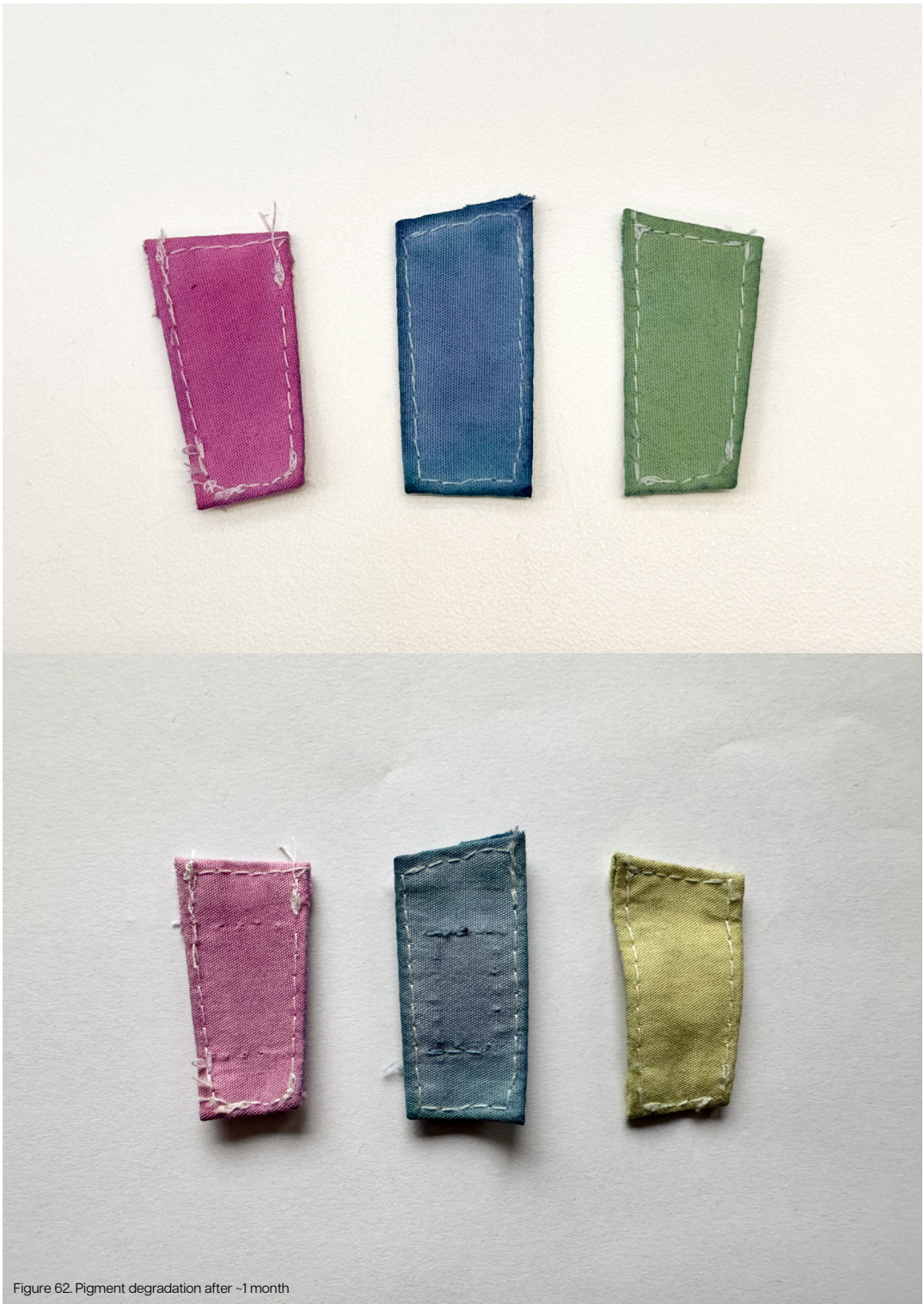


Figure 62. Pigment degradation after ~1 month

8.4.7. Limitations of Anthocyanin Based Halochromic Pigments

A key limitation of organic pigments containing anthocyanin is their poor stability. These pigments degrade when exposed to oxygen, light, and pH changes (Mattioli et al., 2020). We also observed this with our prototype. The colour intensity noticeably degraded after around one month after dyeing.

Since washing and drying involve all these factors, our use of anthocyanin-based pigments represents only a preliminary exploration of halochromic dyes for reactive textiles. Nevertheless, the color-changing property offers an interesting interaction. Our validation process will need to test whether this color change effectively triggers product care and whether users can interpret the color spectrum as an indicator of garment cleanliness.

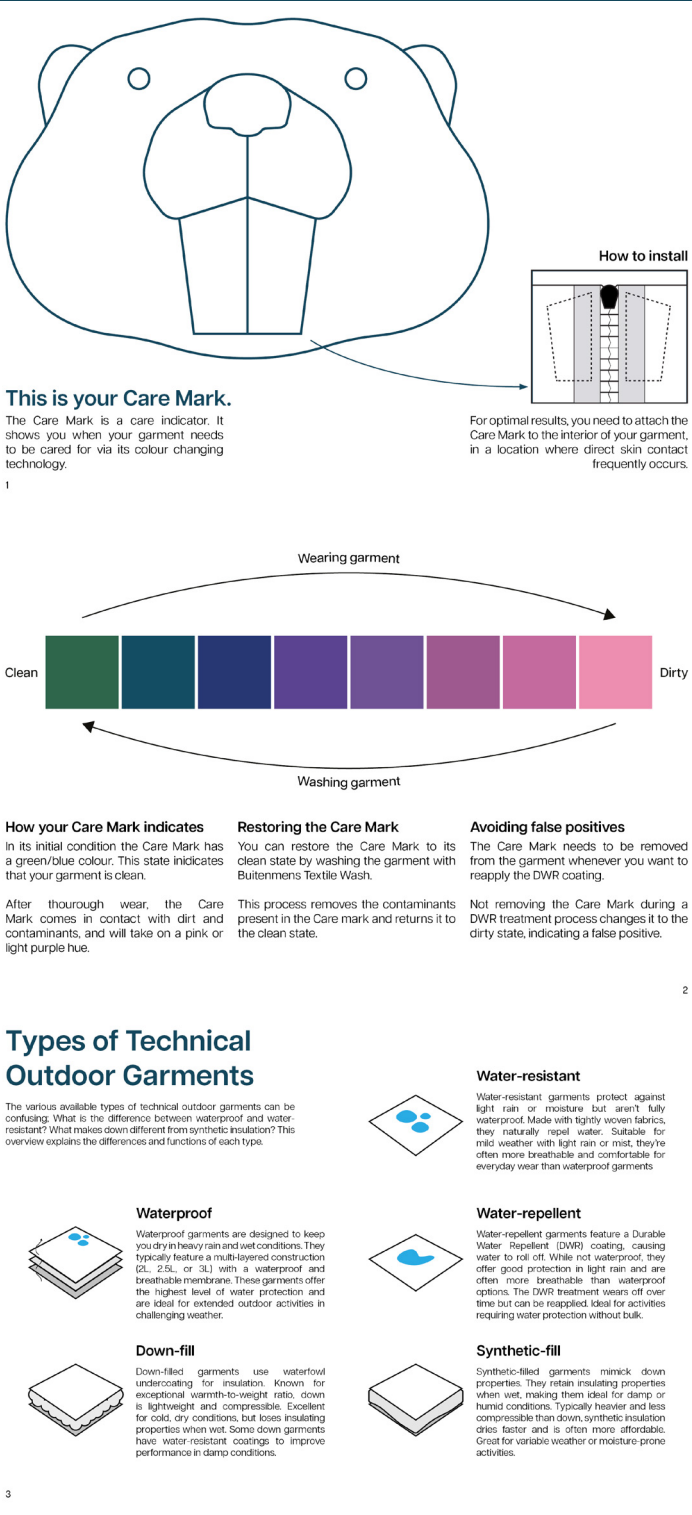
8.5. The Booklet

The Booklet is the informative center of our design. It provides general information about TOG care and how the Care Mark functions. It was created from our earlier collected information about TOG and TOG care into an A5 booklet.

Tailored guidance for each of the TOG types that we identified in the beginning of this report is also available. Each TOG type has its own chapter in the booklet.

The first thing a user would see when opening the booklet, is the Care Mark presented on as the teeth of the Bever. This is accompanied with a guide about the colour changing cycle. In this introductory part the user can also find information about the TOG types and a legend for commonly found care label symbols.

A table of content guides the user to an instruction chapter that fits what they need. Each of these instruction chapters starts with an introduction that informs about required tools and attention points of the TOG in question. After the introduction follow three phases: preparing, washing, and drying. For DWR reapplication there is a separate chapter. The full Booklet can be viewed in appendix D



Care Label Symbol Legend

Washing	 Wash normal, 95 °C	 Wash gently, 30 °C	 Wash very gently, 30 °C	 Hand wash	 Do not wash			
Bleaching	 Any bleach	 Only non-chlorine bleach	 Do not bleach					
Drying	 Medium heat	 Low heat	 Line dry	 Drip line dry	 Flat dry	 Drip flat dry	 Dry in shade	 Do not tumble dry
Ironing	 High heat	 Medium heat	 Low heat	 No ironing	 No steam			
Dry cleaning	 Perchloroethylene & hydrocarbons only	 Hydrocarbons only	 Wet cleaning	 No dry/wet cleaning	 Gentle wash	 Very gentle wash		

Attention Points Explained

Avoid top-loading machine
Top-loading washing machines with agitators can damage waterproof membranes and flatten insulation.
This will affect the garment's protective functions.

Avoid high temperatures
Most technical garments are made from synthetic materials that are sensitive to high temperatures.
This will permanently damage your garment

No wringing
Wringing certain garments can damage their waterproof membrane or overcompress the insulation.
This will affect the garment's protective functions

Wash garment before treatment
Garments need to be washed before reapplying a DWR coating. It will adhere less efficiently on a dirty garment.
This will affect the DWR coating's water repellency.

No regular detergent & fabric softener
Using these products can damage your garment's materials or leave residual particles in the pores of the garment.
This will affect the garment's protective and breathable functions.

Load max. 3 garments
Overloading your washing machine or dryer will cause less efficient cleaning or DWR reapplication.
This will affect garment cleaning and DWR coating bonding.

Table of Contents

How to wash & dry: Waterproof garments _____ pg. 7

How to wash & dry: Down-fill garments _____ pg. 11

How to wash & dry: Water-resistant/repellent garments _____ pg. 15

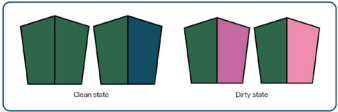
How to wash & dry: Synthetic-fill garments _____ pg. 19

How to restore: Your garment's DWR _____ pg. 23

How to wash & dry: Waterproof garments

Through use, waterproof clothing can lose its functionality. This chapter explains how to wash and dry your waterproof garments properly, and restore its environmental protection. Contaminants can clog the fabric's pores, diminishing breathability. Abrasion and contaminants can also weaken or remove the DWR.

When to clean:



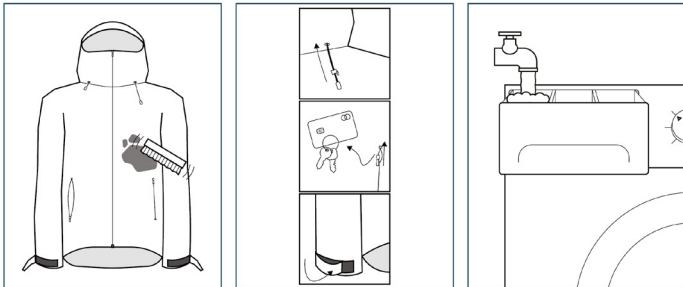
Attention Points:



Tools Needed:



Phase 1: preparing

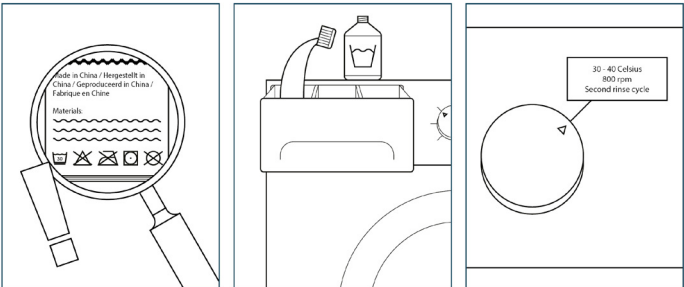


Step 1: Brush off dirt and debris.

Step 2: Fasten velcro, loosen drawstrings, close zippers, and remove items from pockets.

Step 3: Rinse detergent and fabric softener container.

Phase 2: washing

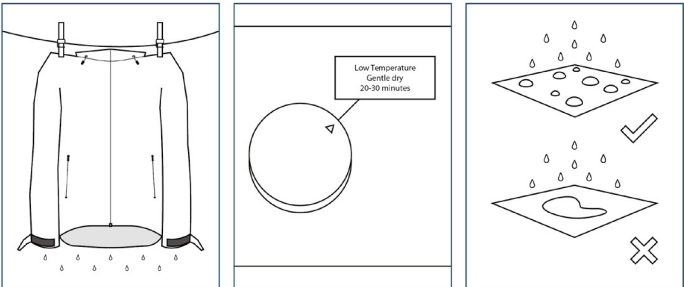


Step 1: Always check the care label for specific warnings and instructions.

Step 2: Add 30-40 ml of Buitennens Sport Textile Wash to the washing machine.

Step 3: Wash the garment on a gentle washing cycle (30-40 Celsius, max. 800 rpm). Add a second rinse cycle to ensure there's no residual detergent.

Phase 3: drying



Step 1: Line dry the garment until dry.

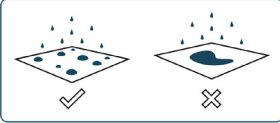
Step 2: If the care label allows, tumble dry at low temperature settings for 20-30 min.

Step 3: Heat usually restores the garment's DWR coating (min. 50 Celsius). Check if water beads off the surface. If not, the DWR coating needs restoring. Continue to page 23.

How to restore: Your garment's DWR

Using your garment will weaken the DWR coating because of dirt or abrasion. This chapter explains how to properly restore your garment's DWR coating and water-repellency. You can easily check if the DWR needs reapplying by spraying water on a garment's fabric. Water should bead off; if not, the DWR needs restoring.

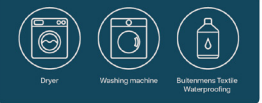
When to reapply DWR:



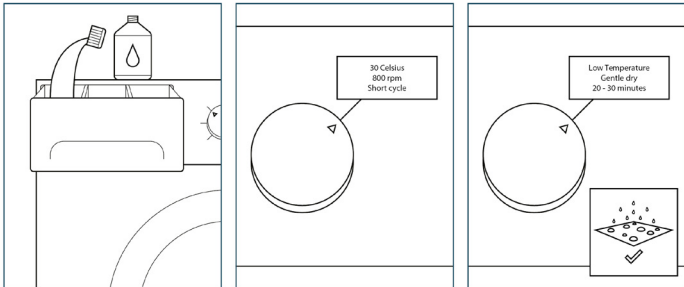
Attention Points:



Tools Needed:



Reapplying DWR



Step 1: Add recommended amount of Buitennens Wash-in Waterproofing to the washing machine.

Step 2: Run a short, gentle washing cycle (30 Celsius, max. 800 rpm).

Step 3: If the care label allows, tumble dry at low temperature settings for 20-30 min. This should activate the DWR. Check if water beads off the fabric.

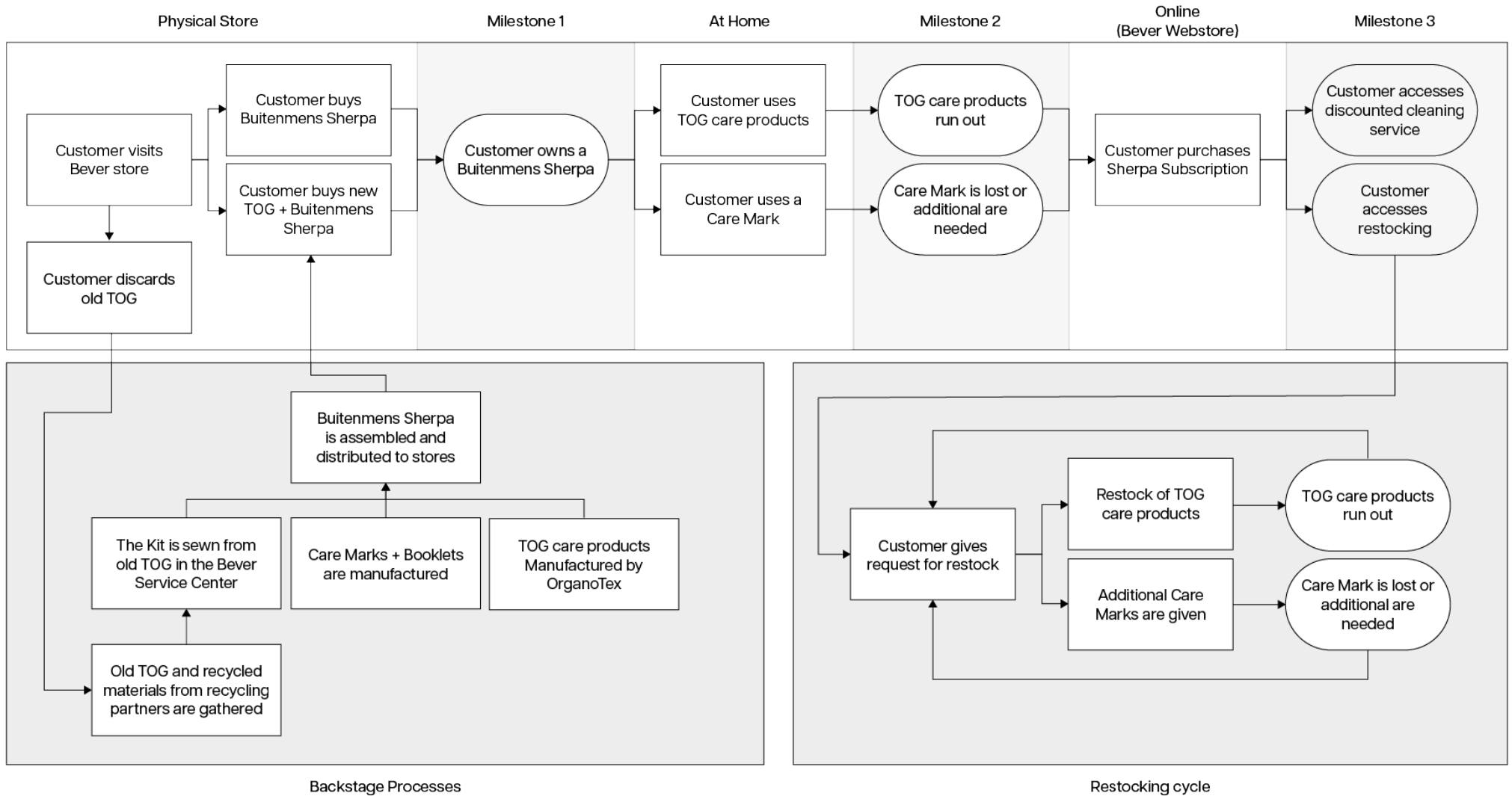


Figure 63. Pss system explained

8.6. The Buitenmens Sherpa as a PSS

Our component based design creates opportunities for a product-service system that could be integrated with Bever's the current services. How this service system would work is portrayed in figure 63.

8.6.1. Customer Journey

The upper bar represents the customer journey.

Physical Store

When they arrive in the store, they have two options to purchase the Buitenmens Sherpa:

1. Buying it separately
2. Buying it discounted in combination with a TOG

Customers are also able to discard their old TOG in the store.

Milestone 1 + At Home

Customer takes their Buitenmens Sherpa home, where they will use the TOG care products and Care Mark. The entire product is their possession.

Milestone 2

After some usage, two things can happen:

1. The TOG care product run out
2. A Care Mark is lost, or additional are needed/wanted for other owned TOG

Online (Bever Webstore) + Milestone 3

Customers are able to purchase a Sherpa Subscription at this point. Which gives them access to:

1. Discounted Bever cleaning services
2. Restocking of the Care Mark and TOG care products.

8.6.2. Backstage Processes

This part explains what needs to happen in order to manufacture the Buitenmens Sherpa.

One of the highlights is the reuse of discarded TOG for the materials of the Kit.

8.6.3. Restocking Cycle

This part elaborates how the restocking process works. When requesting a restock, customers could receive it at home or pick it up at a nearby Bever store..

8.7. Design Validation

After finishing the design, we needed to validate it to assess effectiveness and feasibility. Several validation questions are apparent when we refer to our list of requirements. These formed the foundation of our test.

8.7.1. Validation Questions

Based on our list of requirements, we tried to assess which of the criteria were met. We were able to validate some criteria without actual testing, the entire table can be viewed in appendix E.

We have trimmed these questions, and compiled them into the following main validation questions to answer during our user test. They allowed us to investigate the the Buitenmens Sherpa's usability, desirability, and validity

1. **Is the Booklet easy to understand?**
 - Are the Care Mark instructions clear?
 - Are the TOG care instructions clear?
2. **How intuitive is the Buitenmens Sherpa to use?**
 - How do users interact with the entire system?
 - Does the Care Mark's colour change intuitively and effectively trigger TOG care?
 - Is the A5 booklet size practical during use?
 - How do users perceive the Kit's organization and presentation of tools?
3. **What is the impression of the Buitenmens Sherpa's appearance and design?**
 - What is the impression of the Kit's upcycled aesthetic?
 - What is the impression of the Booklet's aesthetic?



Figure 64. Test setup in Bever store



Figure 65. Participants during the TOG care task

8.7.2. Validation Test Setup

Our setup was placed in the Bever flagship store in the Mall of the Netherlands. Our test protocol was as follows:

1. Introduce the study to the participant.
2. Explain the TOG care task
3. Follow-up interview, consisting of a short survey and open questions.

A participant was given two garments that have Care Marks in different states. They were given the instructions to see which needed maintenance according to the Care Mark status, and to follow the booklet instructions accordingly. They were also instructed to think out loud. While the participant did the activities, we observed their actions.

Afterwards we conducted a short survey and interview with open questions. The test's complete instructions, introduction, survey, interview questions, and observation script can be viewed in appendix F.

8.7.3. Validation Test Results

We were able to gather 14 participants through purposive sampling. Our full notes and observations, along with the summary of these notes, and survey data can be viewed in appendix F

8.7.4. Cost estimation

Due to missing information about employee salaries, logistics costs and time constraints, we were unable to make a precise calculation of production costs. Instead, we examined existing similar products in Bever's product line to establish an estimation of how much our design would cost.

- Gear aid stickers are similar to the Care Mark in terms of adhesive patches for textile. They cost 12.95 (Bever, n.d.-c)
- A Buitenmens Toiletry bag that resembles the Kit costs 39.95 (Bever, n.d.-d)
- Buying a Buitenmens waterproofing and detergent together would cost 43.90 (Bever, n.d.-a)
- If you would order 50 Booklets from PrinterPro, you would pay around 5.11 for one Booklet. (printerpro.nl, n.d.)

In total we would come to an estimated price of 101.91 Euros, which is significantly higher than the 20-50 Euro customer expectation (see appendix F).

Main question	Sub-question	Findings
Is the Booklet easy to understand?	Are the Care Mark instructions clear?	Participants experienced them to be clear, according to quantitative and qualitative data.
	Are the TOG care instructions clear?	
How intuitive is the Buitenmens Sherpa to use?	How do users interact with the entire system?	Overall, people’s interaction with the design went smoothly. There are some points of improvement for the Booklet and Care Mark, however.
	Does the Care Mark’s colour change intuitively and effectively trigger TOG care?	The Care Mark was generally correctly interpreted, causing users to know which jacket needed product care.
	Is the A5 booklet size practical during use?	There were no encountered issues with the A5 size of the booklet.
	How do users perceive the Kit's organization and presentation of tools?	The Kit was described and perceived as an aesthetically pleasing and convenient object.
What is the impression of the Buitenmens Sherpa’s appearance and design?	What is the impression of the Kit’s upcycled aesthetic?	People did not notice that the Kit was made from up-cycled materials unless it was pointed out.
	What is the impression of the Booklet’s aesthetic?	The Booklet gave people a professional and clear impression

8.7.5. Conclusions

Our validation test results indicate multiple key findings. With both qualitative and quantitative data from Bever consumers, we were able to answer our validation questions, observe the strengths of our design, and find areas for potential enhancement and optimization.

- The Care Marks colour indication system proved effective. Most of our participants were able to understand the Care Mark, and correctly interpret its clean/dirty statuses. Some initial confusion was present due to the Care Mark’s novelty. However, the Care Mark instructions in the Booklet, such as the colour cycle visual, provided guidance whenever participants experienced confusion. Some people also had remarks about the influence of the Care Mark on a garment’s aesthetic.
- The Booklet scored quantitatively high on clarity, and when questioned during the interview, people’s answers resonated with that data. Although we observed this positive feedback, the Booklet still needs polishing to create a more refined component: people requested a Dutch version, clearer chapter indexing is needed, and the order of information has to be changed.
- The Kit has been described as an aesthetically pleasing and functional product during the validation test. Its organization and presentation of tools received positive feedback, with participants appreciating its clean design and distinctive appearance. Additionally, people found the Kit straightforward to use. However, the upcycled material aspect was not immediately apparent to most users, and some users prefer a quieter aesthetic.

The results showcase that the Buitenmens Sherpa shows potential to address the challenges of promoting proper TOG care among consumers. High scores for clarity and helpfulness (median score 4 out of 5) and positive qualitative feedback about the entire system suggests that it can be an effective way of lowering the three identified FBM barriers (Ability, Motivation, and Lack of Tools). Furthermore, the Care Mark’s effectiveness as a maintenance trigger demonstrates that this design successfully fulfills Bever’s goal of using visible contamination to prompt proper product care.

8.7.6. Limitations

Several limitations of our validation study must be acknowledged. While we conducted testing with Bever consumers, data collection was limited to a single location (Mall of the Netherlands, Leidschendam) on one day due to time constraints near the end of our thesis.

These constraints also led us to execute a test that was not entirely representative of real-world conditions, potentially affecting participants’ experiences.

Conducting the test on one day, in one location also limited our sample size to fourteen participants, likely drawn primarily from the South-Holland region. This prevents us from generalizing our findings to the broader Dutch Bever consumer population.

Nevertheless, this validation study provided valuable insights into product-user interactions and generated constructive feedback for future design improvements.

9. Project Discussion

This section discusses the key findings, implications, and limitations of the Buitenmens Sherpa.

9.1. Design Evolution

Throughout the development process, our focus remained on addressing the four sub-goals identified through the Fogg Behavior Model and Bever’s feedback: Ability, Motivation, Lack of Tools, and unveiling invisible contaminants. The iterative design process, informed by user feedback, expert consultations, and design methods, led to the creation of a system combining physical indicators (Care Mark), educational materials (Booklet), and practical tools (Kit).

9.2. Design Evolution

While the validation testing showed promising results regarding usability and effectiveness, the cost analysis revealed a significant gap between production costs and customer price expectations. This highlights the need to explore how to lower the cost through further development of the PSS and other strategies. Component-based selling or customized kit versions are also intriguing.

9.3. Impact on Sustainable Consumer Behaviour

Our design demonstrates potential in promoting sustainable consumer behavior by providing the means to extend TOG lifespans through proper care. The high clarity scores and positive user feedback suggest that the system effectively lowers barriers to proper TOG maintenance. However, a longitudinal study might be needed to assess long-term behavioral change.

9.4. Care Mark’s Effectiveness

The Care Mark’s reactive textile was perceived as an effective way to make contamination visible, according to validation test participants. Its color-changing properties provided clear visual cues that helped users identify when maintenance was needed. However, a longitudinal study for the Care Mark is also needed to assess if there is a directly proportional relationship between its color change and loss of function of a TOG. Some people also wondered about its negative influence on the aesthetics of their TOG, which has to be addressed in the future.

9.5. Integration within Bever

The system aligns well with Bever’s Best Services identity pillar and sustainability goals. However, the implementation would require further developing the PSS. Operational aspects such as staff training, logistics, and integration with existing product care services need to be considered.

9.6. Recommendations

We recommend the following for future development of the Buitenmens Sherpa:

General

- Exploration of more cost-effective materials and production methods
- PSS development according to consumer feedback and Bever’s logistics experts

Booklet

- Second iteration of the Booklet, that achieves a clearer layout and indexing
- Add Dutch language support for the Booklet
- Add a bookmark to prevent users from losing where they are in the Booklet

The Care Mark

- Longitudinal study to assess correct directly proportional relationship between color change and loss of TOG function
- Longitudinal study to assess long-term behavioral change
- Change its form to make the Care Mark more aesthetically pleasing

The Kit

- Development of a modular or customizable system, allowing customers to customize their Kit to the TOG that they own
- Further investigate how Bever’s recycling partners and old TOG collection can be utilized for the Kit’s production.

10. Project Conclusion

This thesis has developed a conceptual design that could be a potential solution to Bever’s problem. Namely, our design could promote proper TOG care among Bever consumers. Through user testing and validation we have demonstrated that the Buitenmens Sherpa could effectively address the three identified and adapted FBM barriers (Ability, Motivation, and Lack of Tools). Additionally, the design fulfills Bever’s wish of unveiling invisible contaminants as a trigger for maintenance. In short, we were able to reach our design goal.

The Care Mark’s colour indication system proved effective in triggering maintenance actions, while the Booklet provided clear, accessible instructions that enhanced users’ ability to perform proper care. The Kit’s organization and presentation of tools received positive feedback, though cost considerations suggest the need for alternative pricing or component-based selling strategies.

While limitations in sample size and testing conditions prevent broad generalization of our validation, the results demonstrate that the Buitenmens Sherpa shows promise in extending TOG lifespan through proper care. Due to the conceptual nature of the design, significant further development is needed. We provided a starting point for this, which should focus on cost-optimizations, PSS development, and addressing identified improvements of the three components of our design, while maintaining the system’s core strength in promoting sustainable consumer behaviour.

11. Personal Reflection

Now that I have reached the end of my thesis, I would say that this project made me grow as a designer. I want to acknowledge that I tend to overthink and tunnel vision, intrinsic habits that have negatively affected previous design projects during my time at Delft. During this project, I tried to avoid these habits and worked to break free from getting stuck in overthinking. I reminded myself that design is a nonlinear process, and that it was okay to step back and focus on something else when immediate answers or results weren't forthcoming. Moreover, I realized that I was not alone during the project—meetings with my supervisors and conversations with peers and colleagues provided feedback that was very helpful during the process.

I have had a strong affinity for sneakers and fashion since being a teenager, but as I got older, I started to believe that circularity and sustainability should be inherent to garments. This project allowed me to reach my personal ambitions of contributing to circularity within fashion. I was able to use my analytical strengths as an IDE student to work on solving a problem that is connected with sustainability. Additionally, I'm pleased that I got the chance to work with my hands during the project, something that had intrigued me since I started studying. This project was the first time that I worked with a sewing machine and textile, and it has ignited a strong interest in perhaps starting to work with textile.

I am grateful for the opportunity to be able to finish my academic career with a collaboration with the largest outdoor retailer in the Netherlands. It was insightful and inspirational to see what happens behind the scenes of an organization such as Bever. Sustainability is something that often takes the backseat in most companies, with greenwashing and false promises, but Bever's initiatives show a proper dedication to sustainability. However, working with a large company also provided some learning experiences. Corporate structure and organization was something that I had to adjust to. I had no prior experience with this, and it was nice to have had this experience for my career after graduation. I feel like I know better what to expect now.

Overall, I thoroughly enjoyed this project and am proud of my achievements. The results have boosted my confidence as an industrial design engineer, and I am excited to leverage my experiences of these past six years of studying for the start of my career.