



# Wardrobe Volume, Lifetime, and Use Activity

Report of wardrobe study

**PROLONG // Data for product longevity: Data-driven strategies  
for effective clothing longevity**

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## COLOPHON

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## REPORT SUMMARY

The report 'Wardrobe Volume, Lifetime, and Use Activity' focuses on developing and exploring research methods that can better measure clothing longevity, active use, and wardrobe dynamics in relation to environmental impact assessment. Rather than concentrating only on clothing durability, the study aims to collect data leading to a better understanding of how people actually use, keep, acquire and dispose of clothing over time.

The method is based on a wardrobe study including three parts: wardrobe audits, wardrobe interviews, and three months of participant self-registration of clothing inflow and outflow. In this way, the study combines qualitative and quantitative approaches to capture measurable wardrobe data as well as social, emotional, material, and bodily aspects of clothing use.

A key methodological contribution is the development of the "Wardrobe Use and Age Grid," a visual tool that helps participants estimate how often garments are used and how long they have been owned. Combined with a mathematical model, the method supports estimation of a garment's "Duration of Service" (DoS), measured as active use rather than only material durability. Moreover, this method generates insights into garment-material aspects of high and low DoS.

The study also examines participants' replacement behaviour. Findings suggest that most clothing purchases are not direct replacements of worn-out or unsatisfactory items, but are instead driven by novelty, opportunity, or preference changes. This weakens the assumption that increasing garment longevity automatically lowers production demand. The study introduces a matrix for identifying "pull-based replacement" (acquiring because something needs replacing) and other garment relations driving acquisition and disposal (acquiring due to novelty or convenience, for instance) and provides examples of how environmental benefits from longer-lasting garments occur only when new purchases are delayed.

The report concludes that wardrobe studies can provide valuable data for improving Life Cycle Assessments (LCAs), particularly by combining insights based on users' everyday practices with clothing behaviour with knowledge on wardrobe volumes. At the same time, the limitations of the method are acknowledged, including reliance on self-reporting, snapshot-based data collection, and challenges in capturing long-term wearing behaviour. Overall, the wardrobe study contributes new methods for integrating user behaviour, clothing volumes, and replacement dynamics into Life Cycle Assessments (LCAs), helping policymakers and fashion companies better evaluate the environmental effects of Design for Longevity strategies.

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# 1. INTRODUCTION

The PROLONG project deals with clothing lifetime as a key aspect of the EU Strategy for Sustainable and Circular Textiles. In the Strategy, Design for Longevity (DFL) is presented as an effective way to reduce the environmental impact of the sector (European Commission, 2022). Environmental savings can be achieved if longer product lifetimes reduce the production of clothing, increasing textile resource utilisation, and minimising CO<sub>2</sub> emissions. However, in order to understand if these aims are effectively achieved, methods to measure the effect of Design for Longevity strategies are lacking. The lack of assessment methods and data on clothing ownership and use leads clothing companies to base their garment lifetime strategies on assumptions and hypotheses. Moreover, users remain uninformed about how to navigate Design for Longevity strategies.

The PROLONG project aims to identify the data collection points and the related types of data needed to measure and qualify DFL strategies in Life Cycle Assessments (LCA), with a focus on CO<sub>2</sub> impact beyond production. The area of research thus focuses on the assumptions and practices of companies and users aiming at clothing longevity. The more specific focus of this report is to describe the project's research and results on users' interaction with clothing after the point of sale and the subsequent use, maintenance, and disposal.

This report summarises the outcomes of the project work package 2, Gap identification in users (WP2). Section 1 briefly introduces the reader to the policy context, the considerations about clothing longevity that informed the study design, and the research questions that were posed. Section 2 describes the methods applied and their relevance to tackle the methodological challenges that have emerged from recent policy developments. Section 3 shows the results of the fieldwork, and Section 4 discusses the contribution of this project to methods for clothing use data collection and its limitations, providing recommendations for future developments.

## 1.1 UNFOLDING DESIGN FOR LONGEVITY

Efforts to extend the lifetime of clothing through design include the use of more durable materials, multifunctionality and flexibility in use, and attempts to enable a meaningful relation between people and garments through design (see Maldini & Balkenende, 2017 for a review). However, there is little knowledge about the efficacy of these approaches (Bakker et al., 2014). Users may dispose of products or stop using them for various reasons, such as personal, emotional and social factors, which go beyond the technical durability of the garment and textile

construction (Fletcher, 2012; Niinimäki, 2011). This creates challenges for companies that want to work with Design for Longevity strategies.

Moreover, the environmental savings of longer lasting products are not given. The often-assumed environmental advantages only materialise if demand for new products is delayed as a result, and so does production (Maldini et al., 2025). Research on wardrobe dynamics suggests that the longevity of products alone may not reduce purchases; as there is no direct connection between new purchases and the replacement of items already owned (Maldini, 2019). Therefore, this project takes the uncertainty about the environmental implications of clothing longevity into account in its study design.

Rather than assuming that there is a direct effect of product longevity on reductions in production, and therefore environmental savings, in this research, we consider that this is case dependent. We study the link between lifetimes and volumes rather than assuming that they are inevitably linked, and do not rule out the possibility that product lifetime extension leads to accumulation and, therefore, possible increases in environmental impact (see Figure 1 for a visual representation of this discussion from previous research). These considerations have informed the research design for our user research, where we intend to understand, among other issues, the extent to which acquisition is driven by replacement in different product types, clothing for different occasions, or the demographic characteristics of users.

The relationship between product longevity, reduced demand, and production volumes highlights a key trade-off between the economic viability of companies offering a long product lifetime and the environmental benefits of such practices. This issue is becoming increasingly relevant in light of the EU's recent Eco Design for Sustainable Products Regulation (ESPR), which seeks to eliminate the "fast" from "fast fashion" (European Commission, 2024).

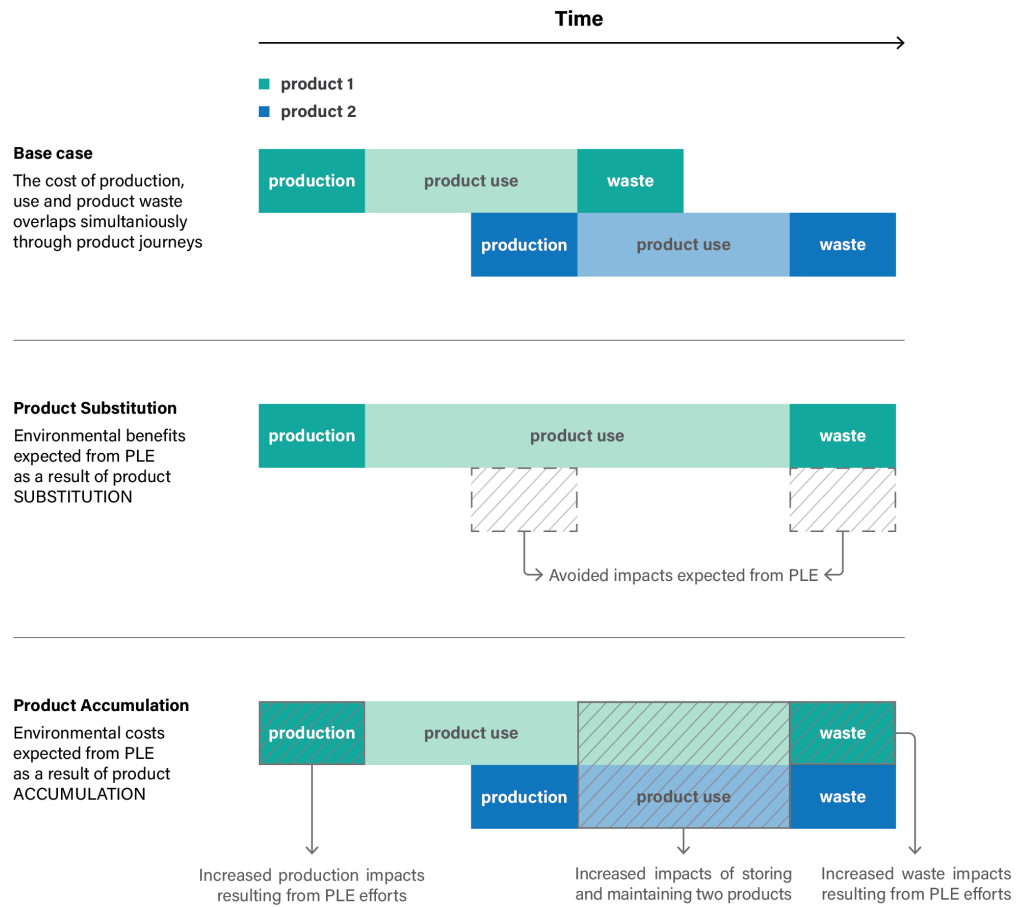


FIGURE 1: ENVIRONMENTAL EFFECTS OF PRODUCT LIFETIME EXTENSION IN A SCENARIO OF MATERIAL SUBSTITUTION VS. ACCUMULATION (MALDINI ET AL., 2025).

The ESPR aims at improving the material durability and robustness of products, and policy discussions now also include factors that are extrinsic to the product (European Commission, 2024). One of the possible unintended consequences of this direction is that the design of more materially durable products promotes those made with synthetic materials, which may also be less preferred for wearing, and therefore lead to even more premature disposal or unused items in the wardrobe. This discussion has been central in the development of the EU Product Environmental Footprint assessment tool (European Footwear Confederation, 2024). In the context of this discussion, **PROLONG focuses on Design for Longevity while aiming for longer active use**. The actual number of wears that a garment experiences over its lifetime is a more accurate indicator than the potential number of wears it can materially withstand (measured, for instance, through lab tests).

In general terms, and after more than a year working with fashion companies in the PROLONG project, we note that Danish brands applying DFL strategies are aware and supportive of this distinction and emphasis (Clausen & Harsaae, 2025). The link with production volume reductions, however, remains rather implicit, and when explicitly discussed, the reductions in production are expected to materialise at the competitors' side rather than their own. There is a tension between product lifetimes and production volumes-focused approaches and strategies, with factors such as competitiveness and economic growth hindering in-depth technical discussions due to their political connotations. In this study, we take this discussion into account, but the main aim is to contribute to environmental policy from a technical perspective, so that environmental assessment methods reflect more fairly the reduced or increased impact of different applied approaches in product design.

## 1.2 UNDERSTANDING VOLUME, LIFETIME, AND USE ACTIVITY

This report contributes to a better understanding of perspectives on clothing volume, lifetime, and use activity as introduced above through a series of wardrobe studies. In leading WP2 on Gap identification in users, Kolding School of Design contributes to the PROLONG project by providing expertise on user studies in clothing design. Together with the other academic partners, it investigates methods and data for measuring clothing lifetime. WP2 seeks to answer the following questions:

- How can we gather data about volumes and flows in the wardrobe to inform LCAs?
- What users and garments follow which flows of replacement, linking lifetimes to clothing volumes?
- How can the Duration of Service (lifetime and active use) be measured in wardrobe studies?

These three interrelated questions are, to some extent, organised from general to specific. Both replacement behaviour and the estimation of active lifetimes are key challenges that LCA should overcome to deliver an accurate assessment of DFL environmental implications. Understanding and considering real replacement behaviour would help to overcome the limitations of material substitution assumptions that are common in LCAs applied to product lifetime extension. Understanding and considering Duration of Service (DoS) instead of the potential number of wears that garments can physically hold is also a necessary step for LCAs to get closer to the actual environmental implications of clothing lifetimes. **Overcoming methodological challenges through the design of the methods for data collection is therefore a key contribution of this**

**project and WP.** Section 2.3 of the methods section includes a discussion of the considerations that were taken in this respect.

## 2. METHOD OF WARDROBE STUDY

The study explores wardrobes in participants' homes while talking to them about their everyday approaches and activities involving clothing. The aim is to gain access to knowledge about what goes on in the use phase, which allows us to better understand actions and motivations that can support clothing longevity. Moreover, the design of appropriate methods to assess the effect of DFL strategies in the use phase is the aim of the PROLONG project.

In the design of the method applied in this research, we intended to collect in-depth qualitative and quantitative empirical data about user and wardrobe activities (Klepp & Bjerck, 2014). The strategy for empirical sampling is inspired by a case study approach that allows for *multiple cases* of users and clothing use situations (Yin, 2009), and to explore context-specific use perspectives of several different individuals by involving people in the setting of their homes, where they keep their clothes (Flyvbjerg, 2015). Meeting people in the surroundings of their wardrobes provides access to the local and everyday practices where they are being lived, rather than from outside and at a distance (Brinkmann & Tanggaard, 2015). For this purpose, we designed the user study drawing on wardrobe methods (Fletcher & Klepp, 2017; Klepp & Bjerck, 2014).

Wardrobe methods explore relations between users and their clothing, whether it is the relation to a specific item or other pieces as part of the entire wardrobe. There are many variations of wardrobe methods, which have been used by several different professional groups for studies in fashion and clothing since the late 1990s (see e.g., Fletcher & Klepp, 2017). The method design for this study involves a wardrobe audit, a wardrobe interview, and a following self-registration of the wardrobe inflow and outflow of clothing.

In this way, the research relies on engaging with people through interviews and observations, as well as registration and photography of objects from the wardrobes, to give access to knowledge about use practices based on the perspectives and everyday lives of specific people (Kvale & Brinkmann, 2016).

### 2.1 RECRUITMENT OF PARTICIPANTS

Participants were recruited using snowball sampling, with academic and company partners in the PROLONG project as a starting point. However, all

participants were external to the participating company and academic institutions.

Table 1 shows additional sampling criteria to cover three age groups for both male and female participants, while being open to non-binary individuals. Furthermore, we strived to cover different types of locations in Denmark, such as bigger and smaller cities, and different areas of the country. Appendix 1 provides selected demographic details of all 24 participants.

TABLE 1. OVERVIEW OF THE OVERALL STRATEGY FOR PARTICIPANT RECRUITMENT.

Age	Male	Female
<i>18-35 years old</i>	4 participants	4 participants
<i>36-55 years old</i>	4 participants	4 participants
<i>56+ years old</i>	4 participants	4 participants

## 2.2 PROTOCOL

The aim of this project's WP2 is to advance methods to better understand volumes and flows in the wardrobe, and to collect knowledge about the lifetime and active use of clothing. Therefore, the wardrobe study includes three phases and tools to be evaluated after the process is concluded: a wardrobe audit, a wardrobe interview, and a period of self-registration of the wardrobe inflow and outflow of clothing. The first two phases are carried out at the participants' homes during approximately two hours, while the third one is conducted online in the following three-month period, when participants register the acquisition or disposal of clothing items. The full protocol of the wardrobe study is to be found in Appendix 2. In the following sections, the methods and tools used in each of the three phases are described.

### 2.2.1 WARDROBE AUDIT

The audit included the count and registration of all clothing items in the participants' homes by researchers, including footwear and accessories such as hats and scarves. The 12 garment types used in the audit are in line with categories applied in other research projects (de Wagenaar et al., 2022; Laitala et al., 2018; Laitala & Klepp, 2020). This allows for comparisons across studies, as a previous review of wardrobe audits has stressed the lack of standardisation in research tools and how it hinders broader analysis (Maldini et al., 2023). Table 2 shows the audit template, including a description of each garment type.

TABLE 2. OVERVIEW OF GARMENT TYPES.

Category	Description of garment types
<i>Footwear (pairs)</i>	Shoes, boots, slippers, etc.
<i>Accessories</i>	Scarves, shawls, hats, gloves (pairs), legwarmers, and other similar accessories
<i>Coats and jackets</i>	Coats and jackets, including sportswear, raincoats, suit jackets, and other similar garments
<i>Trousers</i>	Trousers, including jeans, sweatpants, tights, sleepwear, and other similar garments
<i>Shorts</i>	Shorts, including sportswear, sleepwear, and other similar garments
<i>Skirts</i>	Skirts and other similar garments
<i>Dresses and jumpsuits</i>	Dresses and jumpsuits, including party dresses, beachwear, sleepwear, formal wear, overalls, and other similar garments
<i>T-shirts</i>	T-shirts, including short and long-sleeve T-shirts, upper undergarments, tops, tank tops, and other similar garments
<i>Shirts</i>	Shirts and other similar blouses (with/without buttons and collars)
<i>Sweaters</i>	Sweaters, including cardigans, jumpers, sweatshirts, and similar garments
<i>Underwear</i>	Underwear, including swimwear, panties, briefs, bras, and other similar garments
<i>Socks (pairs)</i>	Socks, including pantyhose

The audit aimed at registering what the participants had at home at the time of the visit. Items left elsewhere were not included. But all areas of the home were considered, including the laundry, clothing stored in suitcases, etc. Appendix 5.

### 2.2.2 WARDROBE INTERVIEW

The interview addressed lifetime and use frequency of garments, footwear, and accessories, while also exploring participants' awareness of longevity and active use of these items. It was audio-recorded and later transcribed and translated using AI-supportive software, GoodTape and DeepL. Moreover, selected clothing items and participants' interactions with these were photographed throughout the interview.

The interview questions can be found in Appendix 2. In order to activate clothing items in the conversation, we designed the Wardrobe Use and Age Grid (see Figure 4). When activating pieces of clothing from the participant's wardrobe, specific garments become a tangible dialogue tool that allows for insights into individual patterns of use (Ravnløkke & Bang, 2016). Integrating clothing items in the interview provides access to aspects of both material, social, and emotional character, as it acts as a basis for the dialogue (Ravnløkke, 2019; Woodward, 2020).

The Grid is a piece of fabric with an imprint of a table with three rows indicating the use frequency of clothing and four columns showing the number of years that participants have owned the clothing (see figure 2).

<b>Use frequency throughout the last year in the right season</b>	<b>Owned for less than 1 years</b>	<b>Owned for 1 - 3 years</b>	<b>Owned for 3 - 6 years</b>	<b>Owned for 6 years or longer</b>
<b>Used (very) frequently</b>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>
<b>Used sometimes</b>	<i>e</i>	<i>f</i>	<i>g</i>	<i>h</i>
<b>Rarely or never used</b>	<i>i</i>	<i>j</i>	<i>k</i>	<i>l</i>

FIGURE 2. THE WARDROBE USE AND AGE GRID.

This research tool builds on previous methods for wardrobe studies as conducted by Maldini et al. (2019) and Ravnløkke (2019, 2023). Maldini et al. (2019) asked participants to first organise clothing items in piles according to the time of ownership, and later according to their frequency of use. In Ravnløkke’s studies (2019, 2024), participants were asked to organise garments into piles by use frequency, while details about the length of ownership and use patterns were discussed in interviews. In this study, we integrate use frequency and length of ownership simultaneously to visually identify patterns of use.

The Wardrobe Use and Age Grid is used to go in-depth into one clothing category for each participant. Each of the garment types listed in Table 2 was assigned to two participants. During interviews, all the items in the selected garment type were put aside, and they were distributed over the Wardrobe Use and Age Grid by participants (Figure 3). The exercise was to first place pre-owned garments in the grid and then supplement with the rest of the garments from this category. Both placements of garments were photographed, and the number of garments in the different cells was documented in the researchers’ forms (see Appendix 6).



FIGURE 3. THE WARDROBE USE AND AGE GRID APPLIED IN THE INTERVIEW.

Placing the garments led to a conversation about the division of items, such as what these placements made the participant reflect upon, and if they could recognise use patterns of the garments, unfolding participants' reasons and motivations for keeping, using, or discarding garments. Then, the interview focused on garments that participants owned for a longer time and are still actively used (garments placed in cell c and d, see Figure 2), and garments that are used rarely or never (cells l, j, k, and l). A selection of these garments was discussed and photographed (see an example in Figure 4).



FIGURE 4. PHOTOS OF GARMENTS AS DOCUMENTATION AND MATERIAL DATA REFERENCE.

The interview also included questions about participants' habits of care and repair, and their ideas about long-lasting garments.

### 2.2.3 PARTICIPANT SELF-REGISTRATION OF WARDROBE INFLOW AND OUTFLOW

Participants were asked to register every garment coming in and out of their wardrobe during the following three months using an online form (Figure 5). The participant handout with information and guidance on how to register the clothing can be found in Appendix 7.

The image shows two side-by-side screenshots of online forms. The left form is titled "New item coming INTO my wardrobe" and the right form is titled "Item coming OUT of my wardrobe". Both forms have a light blue header and a white body. Each form contains the following text: "Please register here any clothes that you receive, buy, or make. You can register only one item at a time. If you need to register several items, you will need to fill the form several times." Below this is a personalized message: "Hi, Irene. When you submit this form, the owner will see your name and email address." A red asterisk indicates a required field: "\* Required". The first question is: "1. What is your **respondent number**? If you do not know your respondent number, please ask the researchers about it \*". Below the question is a dropdown menu with the text "Select your answer" and a downward arrow. The second question is: "2. **What** kind of item is this? \*".

FIGURE 5. SCREENSHOT OF THE ONLINE INFLOW AND OUTFLOW FORM.

The registration of participants' wardrobes *inflow* and *outflow* was collected through two separate forms consisting of 10-11 questions each. They include questions about the characteristics of the items and their expected or past ownership and use, the motivations for participants to acquire or discard clothing, and furthermore, gather insights into people's replacement behaviour. The full set of questions for the Wardrobe Inflow and Outflow form is to be found in Appendix 8.

## 2.3 METHODOLOGICAL CONSIDERATIONS

### 2.3.1 UNFOLDING REPLACEMENT BEHAVIOUR

A key condition for product longevity to lead to environmental savings is that there is an associated delay in demand resulting from a product's extended use, and this applies when products are acquired to replace others that have failed to the user. This failure may be intrinsic (e.g. worn out) or extrinsic (e.g. uninteresting) to the product.

This means that the environmental savings of a product's longevity are not intrinsic to products; they cannot be measured by computing the impacts of a product alone, but are relational, as they depend on the extent to which other products are affected. In this context, one of the conditions for environmental savings to occur is that this product relation in the acquisition phase is based on replacement. Only if products are acquired on the basis of replacement can one expect that product lifetime extension leads to material substitution and not accumulation. If acquisitions are driven by other factors, like novelty or opportunity, and they are not related to the failure of other garments in the wardrobe, the environmental savings are questionable.

Figure 6 shows a conceptual matrix of product replacement elaborated in the context of the PROLONG project, which uses fabricated examples of reasons for product acquisition, building on previous field research (see for example, Harsaae, 2020; Maldini, 2019). The replacement behaviour matrix is organised in two axes, where the vertical one organises a variety of product relations according to the influence of replacement in product acquisition, and the horizontal one according to the direction of this relationship.

In pull-based replacement, new products are acquired due to failures in already owned ones (for reasons that may be material, related to the context of use, life circumstances, etc.). In push-based replacement products are acquired with no or little consideration of what is already owned (presents, impulse purchasing, tempting offers in the market, etc.), and as a result, some other products may (or may not) fall out of use and/or be disposed (see Maldini & Stappers, 2019).

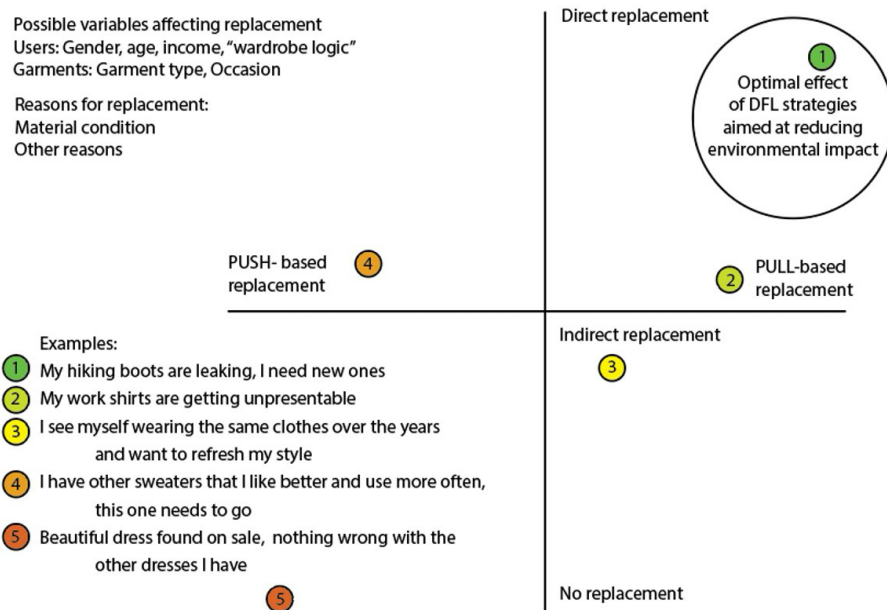


FIGURE 6. REPLACEMENT BEHAVIOUR MATRIX.

The replacement behaviour matrix shows how these elements of replacement can define to what extent product longevity may lead to material substitution based on five examples of reasons for acquisition, which are distributed on the matrix and coded with colours. Examples in the upper right corner of the matrix, and painted in green, point to cases where the product longevity strategies would be effective in delaying demand and potentially contributing to material substitution. Examples in the lower left corner and painted in red show cases in which substitution is unlikely due to non-replacement and push-based relations.

In the design of this study, we took this conceptualisation of replacement into account and applied it to questions in the wardrobe inflow and outflow form. For each item acquired, participants were asked the extent to which they agreed or disagreed with the following statements using a 7-point Likert scale:

- This new item is coming in because another item I have/had needs replacement
- This new item is coming in because I like it/it was easy to get. Nothing wrong with the ones I already have.

The first statement explains acquisition by pull-based direct replacement, while the second statement refers to no replacement or push-based replacement. For the item disposed of, the statements were the following:

- I am disposing of this item because it needs replacement
- I am disposing of this item because I have better ones that I can use

These questions were aimed at answering the second research question of this study: What users and garments follow which flows of replacement, linking lifetimes to clothing volumes? They were intended to identify patterns in the significance of replacement and to investigate their relation to characteristics of products or participants. The overall intention is to understand where DfL efforts may actually lead to reductions in demand and, therefore, environmental impact, and where such efforts may be environmentally ineffective.

### 2.3.2 DoS ESTIMATIONS

Measuring the active life of garments (the number of wears that items experience during their lifetime) is a key challenge for policy to consider the use value for users rather than material durability as an indicator of clothing longevity (see Figure 7). Klepp, Laitala, and Wiedemann have emphasised that “a functional unit for LCAs should emphasise both the number of wears for all users as well as the service lifespan in years. Number of wears is the best measure for regular clothing, while number of years is most suited for occasion wear” (Klepp et al., 2020, p. 1)

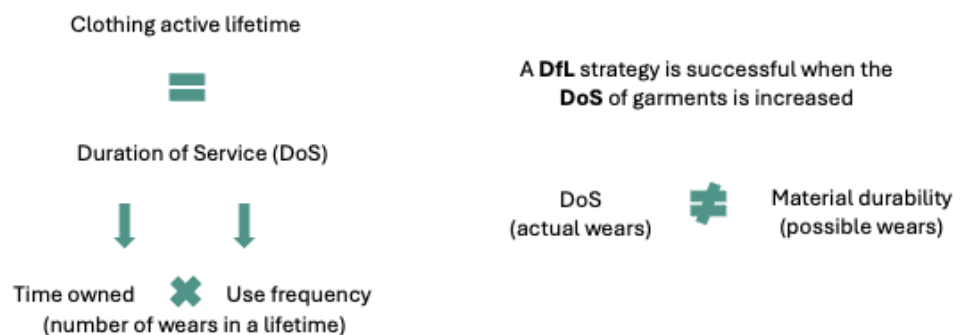


FIGURE 7. ILLUSTRATION OF DIFFERENCES IN MEASURING DURATION OF SERVICE VERSUS MATERIAL DURABILITY.

In our study design, the Wardrobe Use and Age Grid was the main tool to measure DoS in number of wears. This was an additional feature of the tool, which also worked as a communication starter and user reflection elicitation during the

interview (see Figure 8). In bringing together the time of ownership and average frequency of use of items visually and comparatively, the grid helps respondents to overcome difficulties in recalling and generalising use patterns.



FIGURE 8. MATERIALISING AND SYSTEMATISING GARMENTS BY APPLICATION OF THE WARDROBE USE AND AGE GRID.

Some of the methods that have been proposed to estimate DoS are wardrobe surveys (Klepp et al., 2020) and waste audit interviews (Laitala & Klepp, 2024), each presenting specific advantages and disadvantages. Our Grid prioritises the assistance to participants in more accurate recall, and the feasibility of the study, while considering the volume of clothing owned as a key indicator of the items' average use frequency. This factor is usually overlooked in estimations of garments' life spans, even though the more clothes someone owns, the fewer times each piece will be worn on average.

The research design and the application of the Wardrobe Use and Age Grid support participants in verbalising their use behaviour of the specific garment category based on this comparative and tangible approach. Participants cannot estimate the use frequency along the life of garments from the top of their minds; applying the grid provides a comparative and more accurate approach. The application of the grid provides insights into the materiality of the garments while systematising data. With the development of this tool, we contribute with a wardrobe method that can be used to estimate the Duration of Service (DoS).

The distribution of the items on the grid, the number of items owned in this garment type (wardrobe audit), and the number of days per year that this

garment type is used reported by them (extra form) inform a mathematical model. The model can estimate the number of wears of each item, and the average for a participant in a specific garment over time. The characteristics of the mathematical model, developed in collaboration with Assistant Professor, PhD, Heather Logan and PhD Fellow, Valentina Rossi from Danish Technical University, and the full insights gained through it are described elsewhere (Maldini et al., 2026, forthcoming).

Estimating the number of wears is an important challenge for assessments of the environmental costs of garments based on “impact per wear”. Impact per wear is a good way to indicate the environmental value of quality garments, understanding quality as garments that users choose to wear many times. While impact can be estimated with LCAs, we know little about how to estimate the number of wears of an item. This research design, and the application of the Wardrobe Use and Age Grid, in combination with the mathematical model, is one way to do it through wardrobe studies.

#### 2.4 APPLICATION OF THE METHOD

The methods described in section 2.2 guided the field work, which took place between April and October 2025. As expected, it was more difficult to recruit men than women, but the sample distribution finally met the planning. Visits lasted between one and two hours, depending on the wardrobe volume. The researchers involved in the fieldwork were the authors of this report, plus Associate Professor, PhD, Mette Terkildsen and Teaching Associate Professor, Lene Pedersen, from VIA University College. Researchers conducted at least one study together to ensure methodological alignment. Some visits were carried out by an individual researcher, while in other cases, researchers worked in pairs. Selected personal details of respondents are included in Appendix 1. The location information has not been included to preserve anonymity, but the sampling promoted wide distribution across Denmark. The sample includes 4 respondents in the region of Zealand, 6 in Northern Jutland, 11 in Central Jutland, and 3 in Southern Jutland.

A reminder to fill in the wardrobe inflow and outflow form was sent to all respondents once a month. However, several respondents failed to fill them in; most of them were men. The inflow form was filled in by 14 of the 24 participants, and one respondent reported having no inflow. Responses for 74 garment acquisitions were registered. The outflow form was filled in by 10 of the 24

participants, and two respondents reported having no outflow. In total, 91 garments were registered as disposed of.

As the three-month period of self-registration was running, researchers noted the need for specific data that was not part of the protocol. Namely, how often respondents used different garment types. This information was relevant to estimate the DoS of garments in the wardrobe, complementing the data gathered through the Use and Age Grid. Therefore, a new online form was designed to report the number of days a year in which each garment type was used. This extra form, relying on self-estimated averages, was distributed together with the monthly reminders, and it was filled in by 14 of the 24 respondents.

### **3. RESULTS**

This section discusses the results of the wardrobe study in terms of methodological development. The gathered data and findings are presented and summarised in line with the three parts of the method employed, namely:

- Volume and awareness (resulting from the wardrobe audit and interview),
- Longevity and use frequency (resulting from the Wardrobe Use and Age Grid, the interview, and the extra online form on garment type frequency of use)
- Replacement behaviour (resulting from the wardrobe inflow and outflow forms)

#### **3.1 VOLUME AND AWARENESS**

The wardrobe audit showed a significant variation in the sizes of participants' wardrobes. A bigger sample would be needed to run statistics and make reliable generalisations, but as a preliminary finding, the results confirm the variety found in previous studies. The smallest wardrobe holds 87 items, and the largest holds 841 items, which is almost ten times larger. The illustration shows a division of wardrobe volumes into categories of small, medium, and large as shown in the illustration (Figure 9).

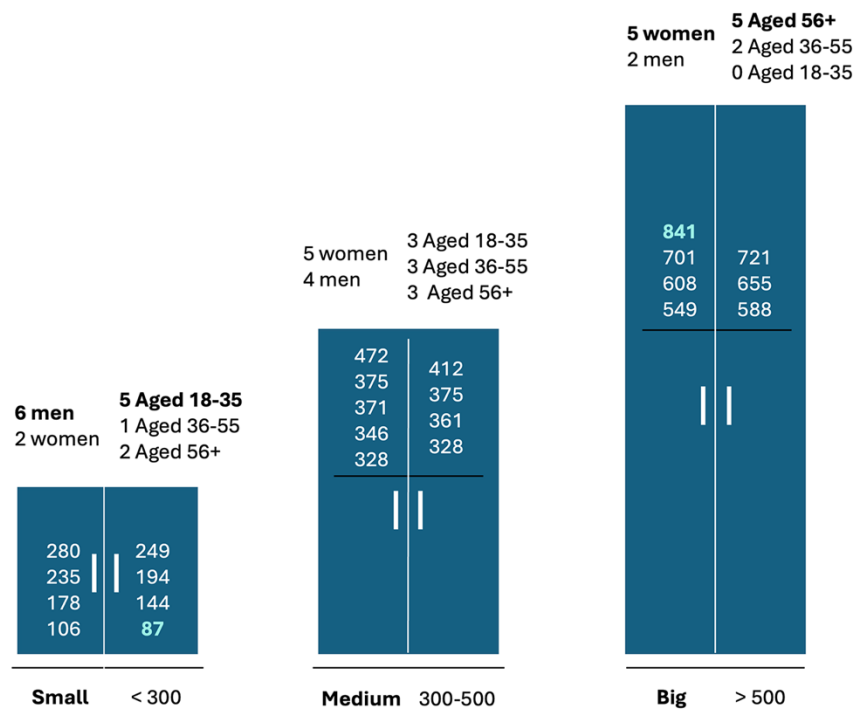


FIGURE 9. WARDROBE VOLUMES AMONGST PARTICIPANTS.

There is a difference in the gender distribution; large wardrobes are more common for women, and smaller wardrobes for most men, but we also see several exceptions in the data set. Patterns are clearer in terms of age, as large wardrobe volumes are more common for participants in the age group 56+ years old, indicating that wardrobes accumulate over time. Both insights are consistent with previous studies in other countries where gender roles and age have a strong influence (Haugrønning & Haugrud, 2024; Maldini et al., 2017). Other demographic variables, like income or living space, do not show a clear influence on wardrobe volume. The full overview of data can be found in Appendix 9.

Taking two wardrobe examples to illustrate the patterns described above (see photo examples in Figure 10):

**Participant 7. male, 29 years old.** Total wardrobe count: 106, Garment type looked at during the wardrobe study: Sweaters. 8 in total, hereof 1 is pre-owned. Yearly household income, 1 person: 250 – 400K. Housing size: 35 m<sup>2</sup>.

**Participant 9. female, 58 years old.** Total wardrobe count: 721. Garment type looked at during the wardrobe study: Footwear: 34 in total, hereof 10 are pre-owned. Yearly household income, 4 persons: 400 – 550K. Housing size: 137 m<sup>2</sup>.



a)



b)



c)



d)

FIGURE 10. WARDROBES OF PARTICIPANTS.

The figure shows photos of the two participants' main wardrobes and additional storage solutions: photos a and b illustrate the wardrobe size and volume of participant 7, and similarly, photos c and d illustrate the wardrobe of participant 9. The two wardrobes provide an example of how differences in age, life situation, and housing size can influence wardrobe volume. In this example, participant 9 is older than participant 7, and has established a family of 4 people in a bigger house.

### 3.1.1 THE AVERAGE WARDROBE

The average wardrobe size in the sample is close to 400 items. The illustration in Figure 11 shows the volume and distribution of garment types in the average wardrobe.



FIGURE 11. THE AVERAGE WARDROBE DISTRIBUTION ACROSS GARMENT TYPES. NUMBERS REFER TO THE NUMBER OF ITEMS IN THESE GARMENT TYPES, AND THE AREA SIZE REPRESENTS VOLUME IN THE ORDER OF SOCKS, T-SHIRTS, ACCESSORIES, UNDERWEAR, TROUSERS, SHIRTS, SWEATERS, FOOTWEAR, COATS AND JACKETS, DRESSES AND JUMPSUITS, SHORTS, SKIRTS, AND OTHER. SEE TABLE 1 FOR A DESCRIPTION OF GARMENT TYPES.

The figure shows that some garment types tend to accumulate more than others. More significantly in larger wardrobes. This is more evident in categories like socks, T-shirts, accessories and underwear. Amongst the smaller categories are shorts and skirts, categories which can be seen to have more specific purposes relating to gender, style, and season. But differences in garment types are also related to how the garment categories were divided.

Dividing the distribution of wardrobe content by gender (Figure 12), women own more items in all categories except shorts and shirts. The men in the sample did not own any dresses or skirts, and owned less than half of the underwear compared to the women. In the wardrobe study research design, items like bras count for underwear and pantyhose count under socks, which are also influenced by gender and may partially explain gender differences in terms of volume.

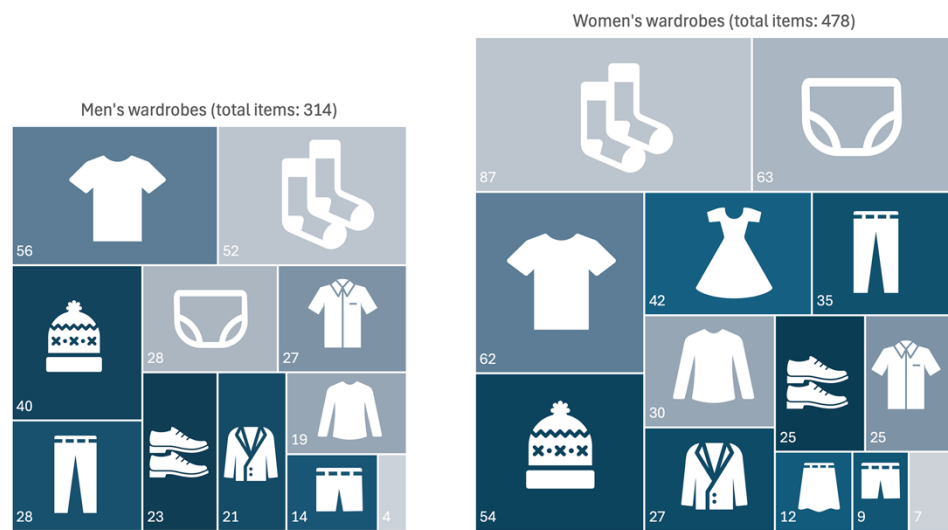


FIGURE 12. AVERAGE WARDROBE DISTRIBUTION BY GENDER. THE BLANK FIGURES ARE IN THE CATEGORY OF OTHER ITEMS.

### 3.2 LONGEVITY AND USE FREQUENCY

The factors affecting the Duration of Service of garments relate to the quantity of garments owned within this garment type, the frequency of use of this specific garment type, the speed of inflow and outflow, including the time that individual items are owned and used. These vary greatly from one participant to another.

In a complementary publication, we have discussed a series of examples about the insights into individual wardrobes and behaviour that can be gained through the Wardrobe Use and Age Grid (Maldini et al., 2026, forthcoming). In this report, we summarise some of the overall quantitative and qualitative results emerging from the interview and the use of this tool.

Figure 13 shows the garments that are considered to have a high DoS and those with a low DoS identified through the grid. However, the number of items in each category and the overall frequency with which they are used are also strong factors affecting DoS. If Figure 13 below (where the trousers owned by Participant 5 are distributed) is compared with the previous Figure 8 (Participant 4's sweaters), the influence of the number of items owned on their DoS becomes evident, as Figure 13 includes more items. This difference, however, is nuanced when also considering the number of days per year that Participant 5 wears trousers and Participant 4 wears sweaters.



FIGURE 13. EXAMPLE OF HIGH- AND LOW-RATED DOS ILLUSTRATED IN THE WARDROBE USE AND AGE GRID.

Figure 14 shows the number of wears estimated when considering all these variables, applied to the example of Participant 9's footwear. The image includes estimations for individual pairs of shoes (the lower-right corner of the figure) as well as the average of all shoes owned by this participant (average DoS per pair).



FIGURE 14. EXAMPLE OF THE ESTIMATED NUMBER OF WEARS.

The averages for other participants are shown in Table 3, which includes all participants who provided the complete requested data. The small size of the sample hinders general conclusions about what kinds of people or garments have a higher or lower DoS, or the factors that affect DoS beyond the ones considered in the design of the method (number of items owned, use frequency of the garment type, time owned, and average use frequency). The table is intended to

show what the method can provide, as methodological progress was the main aim of this WP. Results are organised from highest to lowest DoS. The table includes two examples of respondents with similar demographic details reporting on the same garment type and owning a similar number of garments (see the grey rows in Table 3), showing how the number of days per year they use this garment type affects DoS estimations.

TABLE 3. DoS ESTIMATIONS EMERGING FROM THE GRID AND THE MATHEMATICAL MODEL.

Garment type	Number of items in type	Days used in one year	Low average	High average	Respondent number	Gender	Age
Coats & Jackets	29	300	28	110	8	Female	64
Sweaters	8	100	30	102	7	Male	29
Accessories	14	330	23	100	2	Female	57
Footwear	36	365	19	82	17	Male	52
Underwear	28	365	23	79	1	Female	31
Footwear	35	365	19	69	9	Female	58
Trousers	30	300	16	70	16	Female	26
Pantyhose	75	340	14	56	3	Female	50
Shirts	30	<b>250</b>	12	56	12	Male	57
T-Shirts	39	200	12	48	15	Female	35
Dresses & jumpsuits	47	100	6	23	10	Female	63
Accessories	23	50	4	18	22	Male	58
Socks	136	300	4	17	4	Female	56
Shirts	29	<b>65</b>	4	17	19	Male	52

The application of the Grid during the interview helped to enrich the data with qualitative information, unfolding why some garments remain in use for a long time, while others are used rarely or never within specific wardrobes. The figures below summarise some of this information, showing intrinsic and extrinsic factors mentioned by participants to describe items with a high DoS (Figure 15) and low DoS (Figure 16).






<b>Item</b>					
<b>Intrinsic charac. mentioned</b>	Black Have a bit of wool in them (not in label)	Oversized. Thick (=good). Body can move inside it. Warm. Always stays the same.	Spices up my outfit. Depending on how I fasten the belt, it can signal something else, and it elevates my everyday clothes	Shiny and comfortable	Can be worn across seasons depending on combinations with other garments
<b>Extrinsic charac. mentioned</b>	Good for winter if I wear skirts Have not found a suitable alternative	Good hoodies are expensive, so I have delayed replacement.		They make me feel like someone with Egyptian feet	

FIGURE 15. EXAMPLES OF ITEMS WITH A **HIGH** DoS AND THE CHARACTERISTICS MENTIONED BY RESPONDENTS.






<b>Item</b>					
<b>Intrinsic charac. mentioned</b>	Ugly colours, but they still have a life in them	It's more of a decorative jacket for me	I think it's a nice jacket that when you put it on, it envelops you		
<b>Extrinsic charac. mentioned</b>	I can use them under trousers if everything else is used	It's just a matter of finding the right time and occasion	I'm keeping it because I got it from my aunt	Knitted by my father. Not too cold any more in winter. Memory.	I have several pairs of shoes, and some are forgotten in the back of the wardrobe.

FIGURE 16. EXAMPLES OF ITEMS WITH A **LOW** DoS AND THE CHARACTERISTICS MENTIONED BY RESPONDENTS.

Items with high DoS did not necessarily relate to a “good” brand, “quality”, or material capacity to endure time. The activities in which people engage, the possible combinations with other items, the weather, and many other variables affect the items that people choose to keep and wear significantly. As a result, providing confident advice for designing long lasting products is extremely difficult, as the design of the product may play various roles for the individual user.

### 3.3 REPLACEMENT BEHAVIOUR

After the visits, participants were asked to complete an online questionnaire every time they acquired new clothes (see description of the wardrobe inflow form in section 2.2.3) or disposed of clothes from their wardrobes (the wardrobe

outflow form, section 2.2.3) over three months. Based on these data, this section highlights some of the results indicating participants' replacement behaviour, providing insights into the relation between lifetime, wardrobe volume, and, lastly, environmental impact. The results also exemplify the kind of data that can be generated by applying this method.

### 3.3.1. REASONS FOR DISPOSAL

The wardrobe outflow form was filled in by 10 of the 24 participants. Completed forms were primarily filled in by women. Two men reported that they did not have any outflow of clothes during the period of the study. In total, 91 garments were registered to be disposed of over the period of three months.

The material condition of items disposed of was around one third for items approaching or at the end of their material life (marked in red), and around 1/3 of the disposed of items were considered new or barely used, shown by the green part in Figure 17.

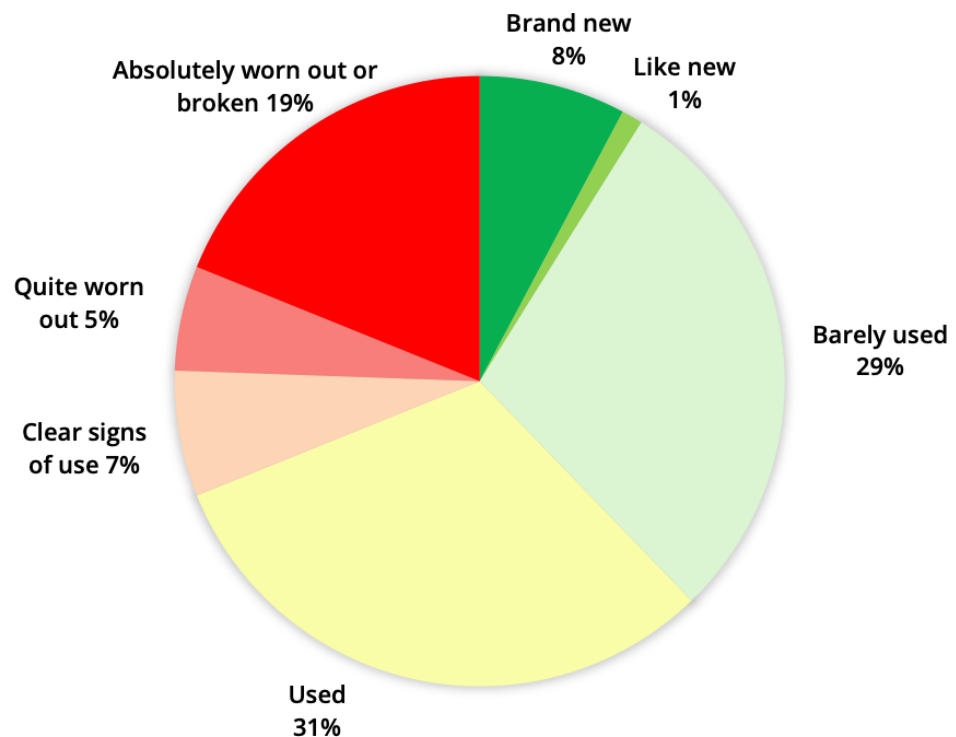


FIGURE 17. MATERIAL CONDITION OF ITEMS DISPOSED OF.

Combining this data with the reasons for garment disposal reported, worn out items are obviously disposed of due to intrinsic reasons related to the material or product construction. Disposals of items in *good* material condition, such as

garments barely used, respond to both intrinsic and extrinsic reasons and can also involve a combination of intrinsic and extrinsic factors. Table 4 shows examples of how participants reported on the reasons for disposal, categorised according to this criterion.

TABLE 4. EXAMPLES OF PARTICIPANTS' STATEMENTS OF ITEMS DISPOSED OF.

Material condition:	Examples influenced by	Participant statements
<i>Absolutely worn out or broken, 19%</i> <i>Quite worn out, 5 %</i> <i>Clear signs of use, 7%</i>	Intrinsic aspects	"These are jeans with stretch where the elastane has become loose"
		"There was a hole in the sock"
		"There was a hole under the sleeve"
		"Worn out, the elastic doesn't hold up as well anymore, the fabric is worn thin, and the fit is no longer right for my body"
<i>Barely used, 29%</i> <i>Like new, 1%</i> <i>Brand new, 8%</i>	Intrinsic aspects	"The fabric was too thick to fold it nicely"
		"Made of polyester, not a material I like anymore"
	Extrinsic aspects	"I have subsequently bought clothes that I use instead"
		"Have a lot of them, because it is my style. I have a lot of sweaters I use instead"
<i>Other participant statements to disposed of garments</i>	Intrinsic aspects	"The fabric makes my skin itch"
		"My legs hurt when I use them"
	Intrinsic and extrinsic aspects overlapping	"I thought it was my style, but I used it a few times"
		"The colour is boring, and I don't like the feel of the fabric"
		"Bad fit. Too loose on the top part, too tight on the bottom part"
		"I used a lot before, but it doesn't seem to be me anymore. I got older"
		"It became too small, unfortunately"

Extrinsic reasons for clothing disposal are related to contextual aspects. For instance, the weather, the activities and occasions for which users dress, changes in life stages or body shape, and the relation of the items with other garments owned (combination possibilities or simply having too many garments to wear all

of them regularly). Other participant statements show how intrinsic and extrinsic aspects affect the motivation for the disposal of their clothes, while participants also refer to other factors such as having “better alternatives”, “bad use experiences”, or “changes in their preferences”. As these statements show, the reason for items to be disposed of varies and is influenced by multiple factors.

### 3.3.2. EXPECTATIONS VS. LIFETIME

Items do not fail prematurely because users acquire them “irresponsibly”, they do not expect the ownership and use of items to be limited. Looking at how participants reported on the clothes they acquired over the three months indicates their expectations for the garment’s lifetime and use frequency. The wardrobe inflow form was filled by 14 of the 24 participants, with a predominance of women in the study. 1 man reported having no inflow. In total, 74 garments were acquired. The results of the inflow form suggest that participants expect to use acquired garments often and keep them for a long time (Figure 18). But as the outcomes of the outflow form show (Figures 17 and 19), these expectations do not meet reality. When disposing of items, participants reported on the time of ownership and average use frequency: 1/3 of the items were disposed of within the first 3 years (left pie diagram), and that 1/3 were worn “very rarely”, “rarely”, or “never”.

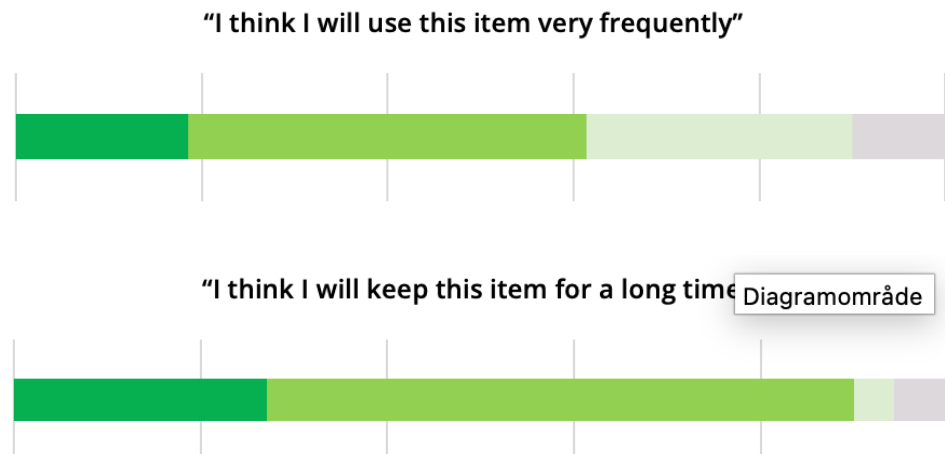


FIGURE 18. PARTICIPANT RESPONDS TO THE TWO QUESTIONS WHEN ACQUIRING NEW CLOTHES.  
\*PARTICIPANTS WERE GIVEN THE FOLLOWING CHOICES TO ANSWER THE QUESTIONS:

- strongly agree
- agree
- somewhat agree
- neither agree not disagree
- somewhat disagree
- disagree
- strongly disagree

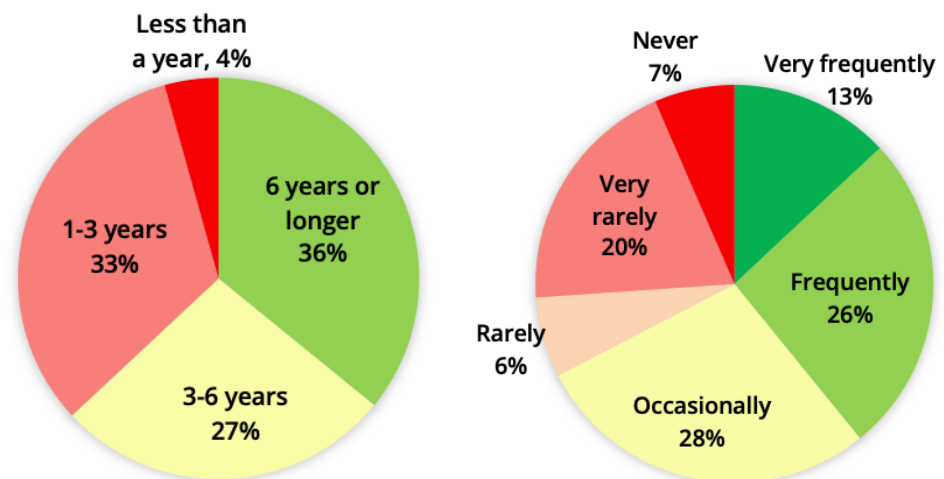


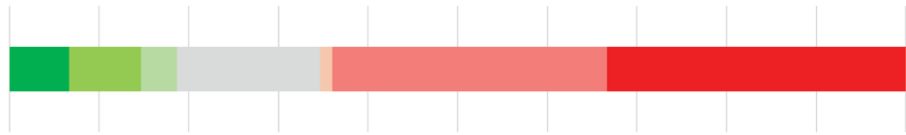
FIGURE 19. TIME OF OWNERSHIP (LEFT DIAGRAM). AVERAGE USE FREQUENCY (RIGHT DIAGRAM).

When considered altogether, the data suggest that garments are worn much less than was first expected by the participant because there are many other items in the wardrobe for which users have “good hopes”. Since users have only one body, garments “compete” with each other and with new items that continue coming in, reducing their potential to be worn more often or for longer. Clothes lose their potential to be worn when they interact with each other in the wardrobe, and they are evaluated comparatively. They are evaluated in isolation during acquisition, but their use and ownership depend heavily on the relationship with other garments in the wardrobe.

### 3.3.3. PARTICIPANTS’ MOTIVATION FOR CLOTHING REPLACEMENT

Figure 20 shows participants’ motivations for acquisition and disposal in relation to product replacement. These questions were intended to better understand how product longevity may lead to environmental savings. Only a few people agreed with the first statement about pull-based replacement, while the second statement, referring to no replacement or push-based acquisition or disposal, was mostly agreed on. Find more participant registrations in Appendix 10.

“This new item is coming in because another item I have/had needs replacement”



“This new item is coming in because I like it / it was easy to get.  
Nothing wrong with the ones I already have”



“I am disposing of this item because it needs replacement”



“I am disposing of this item because I have better ones that I can use”



FIGURE 20. PARTICIPANT RESPONDS TO THE TWO QUESTIONS WHEN ACQUIRING (THE TWO ABOVE) AND DISPOSING (THE TWO BELOW) ITEMS. \*PARTICIPANTS WERE GIVEN THE FOLLOWING CHOICES TO ANSWER THE QUESTIONS:

- strongly agree
- agree
- somewhat agree
- neither agree not disagree
- somewhat disagree
- disagree
- strongly disagree

A general conclusion is that extending the lifetime of most of the garments in our sample would, with a few exceptions, not reduce environmental impacts because the acquisition of new items to replace them would not be delayed or avoided. As described in section 2.3.1, a crucial prerequisite for clothing longevity to result in environmental savings is that it leads to a corresponding delay in demand. This occurs when garments are purchased as replacements for others. For example, when a new jacket is purchased because the previous one lost its water repellent properties, it could be avoided with a more resistant water repellent treatment as an applied Design for Longevity principle.

## 4. DISCUSSION

Coming back to the research questions of this study, this section focuses on the methodological contribution of the work conducted:

- How can we gather data about volumes and flows in the wardrobe to inform LCAs?
- What users and garments follow which flows of replacement, linking lifetimes to clothing volumes?
- How can the Duration of Service (lifetime and active use) be measured in wardrobe studies?

The discussion starts from the more specific second and third questions and then moves towards the main inquiry.

### 4.1 FLOWS AND REPLACEMENT

The data collected through the wardrobe inflow and outflow forms show little relation between the garment types getting into and out of individual wardrobes, with some exceptions, suggesting that direct replacement dynamics are rare. The number of participants answering these questions was small and therefore generalisations should be carefully considered. That said, answers to the replacement question shown in section 3.3 indicate a stronger pull-based replacement logic in **footwear and underwear**. This means that **focusing on product lifetime extension in these garment types is of higher environmental efficacy** compared to dresses, accessories and T-shirts, where reasons for acquisition and disposal were not replacement-related and therefore extending product lifetimes may not lead to reductions in demand or environmental savings. Figure 21 shows this conclusion in relation to the conceptual discussion of replacement in section 2.3. In the rest of the garment types, no clear patterns were found.

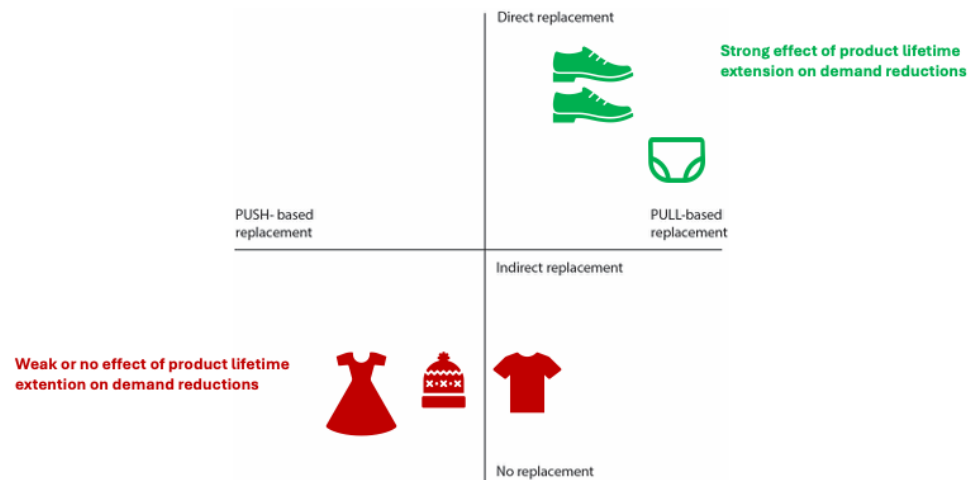


FIGURE 20. GARMENT TYPES AND FLOWS IN RELATION TO THE REPLACEMENT BEHAVIOURAL MATRIX.

Although this finding gives some direction to connect product lifetimes to new product demand and environmental impacts, the main contribution is methodological, as these questions can now be more confidently applied in online surveys with bigger samples to identify other patterns in relation to garment types and demographic details.

The data considered for this question was provided mainly by women, and the lower level of engagement of men with the wardrobe inflow and outflow forms confirms that different approaches may be needed to engage participants of all genders. On the other hand, the specific question of replacement can be asked quite confidently in a one-time online survey and does not need wardrobe studies or diaries to be answered.

#### 4.2 ESTIMATING DURATION OF SERVICE

The approach we have taken in this project to estimate DoS through wardrobe studies has proven **suitable to integrate the key variable of volumes owned, and to assist users in reporting behaviour through comparative assessment and visual tools to enable recall** (the Wardrobe Use and Age Grid). Further, the grid has been complemented with a mathematical model for quantitative estimations. This overall approach, however, presents certain limitations.

A key limitation of the method is that it captures only a snapshot of user behaviour. Data is collected at a single point in time and **does not account for previous use patterns, changes in use frequency over the garment's lifetime, or its future wear potential**. While estimating DoS at end-of-life would offer more accurate comparisons (Laitala & Klepp, 2024), it is more difficult to

implement, as it requires participants to retain and/or document discarded garments for an extended period of time, and to recall past use patterns.

Focusing on garments currently owned is better in this respect, as it offers real-time insights into daily use. But our approach collects data at a specific point in time and does not consider the *future wears* that garments will experience. A major challenge ahead is how to collect reliable longitudinal wearing data, given the level of detail and participant engagement needed, and the gender bias already mentioned. Longitudinal data gathering tools could be implemented through tracking technologies, but previous attempts have proven challenging in terms of privacy, reliance on the self-interest of participants to report, and the disruption of natural use patterns, among other factors. Overcoming such challenges is a promising direction for future research and implementation.

The way that data on the number of wears per year for items in a garment type was collected is another key limitation of the method. The model was fed with the number of *days* per year that participants owned a specific garment type, for instance, trousers. When the data was fed into the model, we assumed that each of these days, only one pair of trousers was worn. **The method did not consider that different trousers may be worn for work, sports, or sleeping in on the same day.**

A complementary data collection tool is needed to overcome this limitation. A diary of outfit changes in a day, and the garment types involved, would be appropriate. Such a tool could either collect wearing data over time or rely on the generalisation of participants' self-reporting a typical day or week, the latter option being of lower accuracy and simpler application, considering the challenges for tracking daily behaviour mentioned above. Combining the number and type of items used in a day with the number of days per year when they are used would mitigate the effect of this assumption and lead to much higher estimations than those shown in Table 3.

If data on daily wearing patterns is successfully collected, it can be easily incorporated in the mathematical model by substituting the number of wears that items in a garment type experience per year with more accurate data. In more general terms, the **scalability and adjustability of the mathematical model** allow for further refining use frequency ranges, cross-garment and user analysis, potentially enabling more robust and generalisable conclusions. **The main challenge is in the development of tools for data collection that are detailed enough to acknowledge the variety and complexity of daily behaviour, while considering the feasibility of their implementation.**

### 4.3 INFORMING LCAs WITH USER DATA

Moving to the main inquiry of this study, the inclusion of data about wardrobe volumes and flows in LCAs is possible. Key methodological contributions of this study are:

- The development of **questions about replacement** that can be asked in a one-time online survey for recent (or even just the most recent) acquisitions and disposals (inflow and outflow). Once bigger data sets are generated, these questions can be translated into a quantitative “replacement rate” for different user profiles and garment types and used to estimate **more realistic material substitution and production savings in LCAs**. The assumption of direct material substitution is a key limitation of current LCAs regarding product lifetime extension (Maldini et al., 2025), which can be overcome in this way.
- Users can confidently report on the **time of ownership and average use frequency at the time of disposal** through the questions developed in our wardrobe outflow form, better informing LCA’s assumptions about the number of wears that garments experience during their lifetime in interaction with different user groups. If this data includes details about materials, brands, etc, DoS patterns to be considered in policy may emerge. This is far from the level of detail and accuracy that the Grid and mathematical model provide, but it is a feasible approach to collect bigger data, while **it allows for connecting DoS patterns with in-depth insights into aspects of body-garment-material as well as social parameters of clothing**. A key aspect that is lost if DoS is estimated in this way is the influence of the volumes owned. Easy-to-collect data about clothing use often overlooks the tonnes of garments that are kept at home, at that bring the average DoS of all clothing down. Considering these items brings much-needed visibility to the connection between DoS and production volumes. That was a challenge that our wardrobe studies addressed, but the trade-off with the number of participants that can be involved may lead future studies to take a different direction.

#### 4.4 INFORMING DATA COLLECTION POINTS

The work carried out in the PROLONG project's WP2 has evolved around the use phase of clothing in relation to the three main themes:

- Volume and awareness
- Longevity and use frequency
- Replacement behaviour

These three themes have been presented and unfolded throughout this report with the intention of providing insights for further work in the PROLONG project. Based on the application and design of methods for our wardrobe study, new themes and sub-questions have emerged. Table 5 shows these emerging themes and related questions that are meant to serve as a driver for discussing further how user studies can inform data-collection concepts for relevant points and data-driven recommendations for companies' design and business strategies.

TABLE 5. OVERVIEW OF EMERGING THEMES.

Theme	Questions for discussion and further work
<i>Intrinsic and extrinsic factors for clothing longevity</i>	What are the elements that can be incorporated during product development to extend clothing lifetimes?
	What other actions can support intrinsic product characteristics (for example, customer support, outfit and wardrobe advice, etc.)
	What other actions could fashion or/and data companies engage in to also influence extrinsic factors preventing garments to last long? (for example, volumes, expectations of novelty and variety, gift giving, occasions and appropriate clothing, etc.)
<i>Replacement and the relation between lifetimes and volumes</i>	How can fashion companies promote a pull-based direct replacement user behaviour so that longer lifetimes result in reduced demand?
	Where is this reduced demand expected to happen, what will support this behaviour, and what are the mechanisms to drive such change?
	To what extent will reductions in demand lead to reduced production in fashion companies, and how will it affect the business strategy?
<i>DoS integration in LCAs and impact per wear estimations</i>	What is the previous experience of fashion companies in understanding how long their products are used?
	How can solutions offered by data companies help?

	How should DoS be considered in LCAs?
	Can concepts of impact or cost per wear drive a positive change?
<i>Scalability of wardrobe research and its use by businesses</i>	How can a wider group of relevant participants be reached in future user studies, while still acknowledging the variety and complexity of user behaviour?
	How can wardrobe study inspired methods be adapted by or to fashion companies, to deliver useful insights on the use phase?
	How can data companies support wardrobe study inspired methods applied in fashion companies?

Throughout the report, we have presented and discussed methods for collecting data from wardrobe studies; however, this does not establish how to implement these methods systematically from a company or policy perspective. Rather, we have advanced a direction to include the volume or products in circulation, the use value delivered, and the nature of product replacement as integral aspects of product lifetimes and longevity assessment and research. This direction opens opportunities for collaboration and experimentation on how to implement data collection efforts, considering the interests and possibilities of actors across the value chain, including designers, businesses, users, and policymakers.

Suggestions to implement the methods and findings of this study into DFL strategies include: the identification of products following a direct and pull-based replacement, such as underwear and shoes in this study, to design products with intrinsic durability in mind. In other cases, where garments do not follow this kind of replacement logic, an emphasis on production reduction is more appropriate.

During the fieldwork, we identified items that work very well for users but that they cannot find direct replacements for when worn out. Identifying such products and ensuring that they are in a permanent offer is an approach that could increase the average DoS of a brand's production. Some fashion companies already experiment with programs of products that are *never out of stock* (NOS) to support customer loyalty as a strategy. Experimenting with and innovating on such programs further is a promising direction to enable brand-user communication and collaboration, to align production with actual use patterns. Data collection concepts suitable for specific users, products or brands can emerge from such collaboration. However, to establish these collaborations to better understand the detailed parameters at play requires new avenues. Although the concrete assessment of DFL strategies' impact can help companies

to substantiate their claims, the most impactful application of data collection concepts would be at the policy level. It is at this level that the relation between longevity and overall reductions in production can be monitored and enabled.

## **5. FUTURE RESEARCH**

While this WP has focused on methodological development, the fieldwork conducted also shows how the method can be used to generate insights. The wardrobe study explores people's everyday life with their clothes and opens doors to a better understanding of actions and motivations in the use phase. Future research can dive deeper into the data to unfold how design can support a high Duration of Service in Design for Longevity.

The results of the wardrobe study suggest limitations in how design can influence and affect environmental improvements in relation to rates of replacement. But the data gathered also provides insights into the material aspects of clothes (textiles, construction, drape, etc.) as well as bodily, individual, and social aspects of, for instance, material feel, product fit, style, and culture linked to the DoS of garments at a specific point in time. These empirical data may hold insights applicable to design, not only at the level of product and collection development, but also at the business strategic and systemic level that can be considered in more detail in the following WPs of the PROLONG project.

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## APPENDIX

### 1. OVERVIEW OF PARTICIPANT DEMOGRAPHICS AND OTHER INTERVIEW DETAILS

<i>Respondent number</i>	<i>Location in Denmark</i>	<i>Gender</i>	<i>Age</i>	<i>Interview language</i>	<i>Garment type discussed</i>
1	South Jutland	Female	31	English	Underwear
2	Central Jutland	Female	56	Danish	Accessories
3	Central Jutland	Female	50	Danish	Socks (pantyhose)
4	Zealand	Female	55	English	Socks
5	Zealand	Female	55	English	Trousers
6	Zealand	Male	25	English	T-shirts
7	Zealand	Male	28	English	Sweaters
8	North Jutland	Female	64	Danish	Coats and Jackets
9	South Jutland	Female	58	English	Footwear
10	South Jutland	Female	63	Danish	Dresses and Jumpsuits
11	North Jutland	Male	34	Danish	Shorts
12	Central Jutland	Male	57	Danish	Shirts
13	Central Jutland	Female	26	Danish	Dresses and Jumpsuits
14	Central Jutland	Male	37	Danish	T-shirts
15	North Jutland	Female	35	Danish	T-shirts
16	North Jutland	Female	35	Danish	Trousers
17	Central Jutland	Male	52	Danish	Footwear
18	Central Jutland	Male	50	Danish	Coats and Jackets
19	Central Jutland	Male	52	Danish	Shirts
20	Central Jutland	Male	64	Danish	Sweaters
21	Central Jutland	Male	58	Danish	Underwear
22	North Jutland	Male	58	Danish	Accessories
23	North Jutland	Female	40	Danish	Dresses and Jumpsuits
24	Central Jutland	Male	24	Danish	Shorts / Trousers

### 2. PROTOCOL OF WARDROBE STUDY

#### RECRUITMENT

First call, and if not reachable, write an email:

- Explain the project and its relation to companies

- The exercise (length, activities: demographic details, inventory + exercise/interview with one garment type, follow up for 3 months) with 1 or 2 researchers present
- We will audio record, we will take photos of clothes, not people, mention the consent form and send it by email after the talk.
- +1
- Availability in the first period or later
- Comfortable doing it in English?
- Address, age
- Fill the participants' table

#### TO BRING TO THE VISIT

- Laptop computer
- Printed forms for personal details and audit (plan B)
- Printed protocol
- An audio recording device and a separate photo device
- Grid and background fabric
- Printed consent form

#### VISITING THE PARTICIPANT FOR WARDROBE AUDIT AND INTERVIEW

##### THEME 1: VOLUME AND AWARENESS

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1. Remind the respondent of the objective of the study and sign the consent form
2. Start recording
3. Fill the form with personal details on a computer or paper
4. Take one or more photos of "the wardrobe"

Warm-up conversation questions about the participants understanding of longevity:

- What is a long-lasting garment for you?
  - Do you do something to keep your garments for a long time?
  - If yes, what? And why?
5. Stop recording
  6. Start the inventory using the second form
  7. Wardrobe content is registered, assisting the participants in counting and noting the numbers of the different garment types (footwear, accessories, coats and jackets, trousers, shorts, skirts and other similar garments, dresses and jumpsuits, t-shirts, shirts and other similar blouses, sweaters, underwear, socks)

8. Audio record the interview and record details of garments discussed through photos, count garments using the third form page.

### **2.1) Use Patterns – One Garment Type (understanding why)**

9. Extend the use frequency grid and background fabric
10. Start recording again

One of the garment types (e.g. trousers) is collected, and all items are organised in the use frequency grid, based on period of ownership and use frequency.

#### **2.1.1 First, do this exercise only with pre-owned garments in this category**

11. Ask, for example, participants to lend a little ladder or stool to take a photo(s) of the overview.
12. The numbers of items are counted and registered in the form.

#### **2.1.2 Add all other garments in this category**

Together with the participant, reflect on what is going on in the grid. Ask the participant to think aloud with the questions:

- What are you considering while placing these garments?
- Do you see any patterns in relation to the occasions or activities when you use these garments?

13. Take a photo(s) of the overview.
14. The numbers of items are counted and registered in the form.

### **2.2) Understanding Longevity (how and why)**

The next steps of the interview dwell on specific items placed in the use frequency grid.

#### **2.2.1 Focus on the top right corner of the grid (very frequently used and 5+ years old, cells C and D, if no garments there, use cells G and H). Let them explain why these are special by asking the questions:**

- What are the reasons and motivations for the placement of the garment?
  - Do these have something in common? Always push comparisons with other garments in the same category.
  - How have these garments evolved with you? What in them made them fit your life for a long time?
15. Take photos of garments and labels of the specific garments discussed on the background fabric, max 5 pieces.

16. Researchers refer to characteristics of specific garments aloud, to be able to link them to the audio later.
17. After photos, garments go back to their place in the use frequency grid.

### **2.2.2 Focus on the rarely or never used**

- What are the reasons and motivations for having these garments in the wardrobe?
18. Take photos of garments and labels of specific garments discussed using the background fabric, max 5 pieces.
  19. Researchers refer to characteristics of specific garments aloud, to be able to link them later.
  20. After photos, garments go back to their place in the use frequency grid.

### **2.3) Patterns of Maintenance and Care (understanding how)**

- Looking at the garments in the grid: What are your habits/needs for cleaning and caring?
  - Wears/washes and how (airing, temperature, separation, drying method, ironing)?
  - Are there differences across the pieces in the grid? Can you discuss some examples?
  - Have any of these garments needed repair? If so, what kind of repair and how did you approach it (professional service, self-repair, other)
21. Researchers refer to characteristics of specific garments aloud, to be able to link them later.

### **2.4) Reflecting back**

- After going through this exercise, have your ideas about long-lasting garments changed in some way? How?
  - What do you think companies could do to promote an active, long life for garments?
  - What could you do to promote that further?
22. Stop recording.

### 3. TEMPLATE FOR PARTICIPANT DETAILS

<b>1.1 Personal details</b>	
We need some information about you to be able to conduct the full study and to contextualise the findings. These details are going to be processed anonymously.	
Today is (date)	<input type="text"/>
Your full name (only visible to researchers)	<input type="text"/>
Gender	<input type="text" value="Click here"/>
Year of birth	<input type="text"/>
Profession	<input type="text"/>
Personal job situation	<input type="text" value="Click here"/>
Number of people in your household	<input type="text"/>
<b>Household</b> income * (yearly, nominal)	<input type="text" value="Click here"/>
<small>* We will use the data above to calculate income per person in the household. Your response will be processed anonymously and will not be used for other purposes.</small>	
House size (m2) **	<input type="text"/>
I am living in this house since (year)	<input type="text"/>
Researcher's estimation of storage volume 1 (3 dimensions)	<input type="text"/>
Storage 2 (3 dimensions)	<input type="text"/>
Storage 3 (3 dimensions)	<input type="text"/>
<small>** If you have/use more than one house, please consider your main home only.</small>	

## 4. WARDROBE AUDIT TOOL

<b>1.2 Wardrobe inventory</b>					
<b>Garment type</b>	<b>House area 1</b>	<b>House area 2</b>	<b>House area 3</b>	<b>House area 4</b>	<b>Total</b>
<b>Footwear (pairs):</b> Shoes, boots, slippers, etc.					
<b>Accessories:</b> Scarves, shawls, hats, gloves (pairs), legwarmers, and other similar accessories					
<b>Coats and jackets:</b> including sportswear, raincoats, suit jackets, and other similar garments					
<b>Trousers:</b> Including jeans, sweatpants, tights, sleepwear, and other similar garments					
<b>Shorts:</b> Including sportswear, sleepwear, and other similar garments					
<b>Skirts</b> and other similar garments					
<b>Dresses and jumpsuits:</b> Including party dresses, beachwear, sleepwear, formal wear, overalls, and other similar garments					
<b>T-shirts:</b> Including short and long-sleeve T-shirts, upper undergarments, tops, tank tops, and other similar garments					
<b>Shirts</b> and other similar blouses (with/without buttons and collars)					
<b>Sweaters:</b> Including cardigans, jumpers, sweatshirts, and similar garments					
<b>Underwear:</b> Panties, briefs, bras, and other similar garments					
<i>Swimwear</i>					
<b>Socks (pairs):</b> Including pantyhose					
Other garments outside the mentioned categories					

Clothes that are co-owned with other people, and clothes kept outside your main home (for instance, in your partners' home or a summer house) are excluded from this study. Clothes kept at home that are not in use (for instance, they are separate to give away but have not been given away yet) should be counted.

## 5. ESTIMATING YEARLY USE OF GARMENTS, FOOTWEAR AND ACCESSORIES

Garment type	Estimating yearly use of garments, shoes and accessories
<b>Footwear (pairs):</b> Shoes, boots, slippers, etc.	<i>For example, 365 days yearly</i>
<b>Accessories:</b> Scarves, shawls, hats, gloves (pairs), legwarmers, and other similar accessories	
<b>Coats and jackets:</b> including sportswear, raincoats, suit jackets, and other similar garments	
<b>Trousers:</b> Including jeans, sweatpants, tights, sleepwear, and other similar garments	
<b>Shorts:</b> Including sportswear, sleepwear, and other similar garments	
<b>Skirts</b> and other similar garments	
<b>Dresses and jumpsuits:</b> Including party dresses, beachwear, sleepwear, formal wear, overalls, and other similar garments	
<b>T-shirts:</b> Including short and long-sleeve T-shirts, upper undergarments, tops, tank tops, and other similar garments	
<b>Shirts</b> and other similar blouses (with/without buttons and collars)	
<b>Sweaters:</b> Including cardigans, jumpers, sweatshirts, and similar garments	
<b>Underwear:</b> Panties, briefs, bras, and other similar garments	
<i>Swimwear</i>	
<b>Socks (pairs):</b> Including pantyhose	
Other garments outside the mentioned categories	

## 6. TOOL TO COUNT GARMENT'S PLACEMENT IN THE GRID

### PRE-OWNED GARMENTS

<b>Use frequency during the last year in the right season</b>	<b>Owned for less than 1 year</b>	<b>Owned for 1-3 years</b>	<b>Owned for 3-6 years</b>	<b>Owned for 6 years or longer</b>
<b>Used (very) frequently</b>	A	B	C	D
<b>Used sometimes</b>	E	F	G	H
<b>Not used in the last year/ yet</b>	I	J	K	L

### ALL GARMENTS WITHIN THE GARMENT CATEGORY

<b>Use frequency during the last year in the right season</b>	<b>Owned for less than 1 year</b>	<b>Owned for 1-3 years</b>	<b>Owned for 3-6 years</b>	<b>Owned for 6 years or longer</b>
<b>Used (very) frequently</b>	A	B	C	D
<b>Used sometimes</b>	E	F	G	H
<b>Not used in the last year/ yet</b>	I	J	K	L

## 7. PARTICIPANT SELF-REGISTRATION HANDOUT

The second part of this wardrobe study involves a registration of any clothes coming IN and OUT of your wardrobe during three months, starting at the date of our visit. The registration is done online using a phone or computer and it takes just a minute. You do not need to sign in with your email. If possible, please register any movement as soon as it happens.

The period of registration in your case is \_\_\_\_\_ to \_\_\_\_\_ .

Your respondent number is \_\_\_\_\_ .



Please register here any clothes that you receive, buy, or make starting from the date of our visit for three months. You can register only one item at a time. If you need to register several items, you will need to fill out the form several times. If you reach 20 items registered in this form, you may stop filling it in, but please email us explaining if these are common or special circumstances, with a little description. Thanks!

<https://forms.cloud.microsoft/e/2TAK97pCzR>



Please register here any clothes that you lose, sell, give away, or throw away starting at the date of our visit for three months. You can register only one item at a time. If you need to register several items, you will need to fill out the form several times. If you reach 20 items registered in this form, you may stop filling it in, but please email us explaining if these are common or special circumstances, with a little

description. Thanks!

<https://forms.cloud.microsoft/e/JqWEyEaKA7>

## 8. INFLOW AND OUTFLOW QUESTIONNAIRE FRAMEWORK

### INFLOW FORM

#### **New item coming INTO my wardrobe**

Please register here any clothes that you receive, buy, or make starting from the date of our visit for three months. You can register only one item at a time. If you need to register several items, you will need to fill out the form several times. If you reach 20 items registered in this form, you may stop filling it in, but please email us explaining if these are common or special circumstances, with a little description. Thanks!

1. What is your respondent number? If you do not know your respondent number, please ask the researchers about it.
  - Select your answer: numbers
2. Please select the kind of garment that describes this item most accurately
  - Select your answer: garment categories as translated in the wardrobe count form.
3. Any other characteristics of the item that you want to mention?
  - Free field
4. Why did you get it?
  - Free field
5. Is this a new or pre-owned item?
  - New
  - Pre-owned (e.g. bought second-hand or received from a previous owner)
6. How did you get it?
  - I bought it online
  - I bought it in a physical shop
  - It was given to me
  - I found it somewhere
  - I made it
7. If it was bought. How much did you pay for it (in DKK)?
  - Value field
8. How is the material condition of the item that you are getting?
  - Brand new
  - New
  - Like new
  - Used
  - With clear signs of use
  - Quite worn out

- Worn out or broken
9. Please indicate to what extent you agree with these statements. I got this new item because:

Another item I have/had needs replacement

I did not have (enough) good ones of this kind. For instance, enough sports pants

I like it / it was easy to get. Nothing wrong with the ones I already have

10. Please indicate to what extent you agree with these statements.

I think I will use this item very frequently

I think I will keep this item for a long time

#### OUTFLOW FORM

##### **Item coming OUT of my wardrobe**

Please register here any clothes that you lose, sell, give away, or throw away starting at the date of our visit for three months. You can register only one item at a time. If you need to register several items, you will need to fill out the form several times. If you reach 20 items registered in this form, you may stop filling it in, but please email us explaining if these are common or special circumstances, with a little description. Thanks!

1. What is your respondent number? If you do not know your respondent number, please ask the researchers about it
  - Select your answer: numbers
2. Please select the kind of garment that describes this item most accurately
  - Select your answer: garment categories as translated in the wardrobe count form.
3. Any other characteristic of the item that you want to mention?
  - Free field
4. Why did you dispose of it? Please be as specific as possible. Avoid responses such as "I had not used it for a long time". Why weren't you using it, then?
  - Free field
5. Was this item new or pre-owned when you got it?
  - New
  - Pre-owned (e.g. bought second-hand or received from a previous owner)
6. How did you dispose of it?
  - I placed it in a textile container

- I placed it in my normal trash bin
  - I gave it away to someone I know
  - I took it to a second-hand shop or local charity shop
  - I sold it online
  - I tore it down or used it for other purposes (for instance, as a cleaning cloth)
  - I lost it
7. If you have sold this item. How much did you sell it for (in DKK)?
- Value field
8. How is the material condition of the item that you are disposing of?
- Brand new
  - New
  - Like new
  - Used
  - With clear signs of use
  - Quite worn out
  - Worn out or broken
9. Please indicate to what extent you agree with these statements. I am taking this item out of my wardrobe because:

I need to get/buy a specific item to replace this one, or I have bought it already

It is not good enough (anymore). I need(ed) better ones of this kind

I have better ones that I can use

10. I owned this item for:
- Less than one year
  - 1-3 years
  - 3-6 years
  - More than 6 years
11. While I owned this item, I used it (on average):
- Very frequently
  - Frequently
  - Occasionally
  - Rarely
  - Very rarely
  - Never

## 9. TABLES OF RESULTS FROM THE WARDROBE STUDY

### 3.1 OVERVIEW OF PARTICIPANTS' DETAILS, INCOME, HOUSE SIZE, AND WARDROBE VOLUME

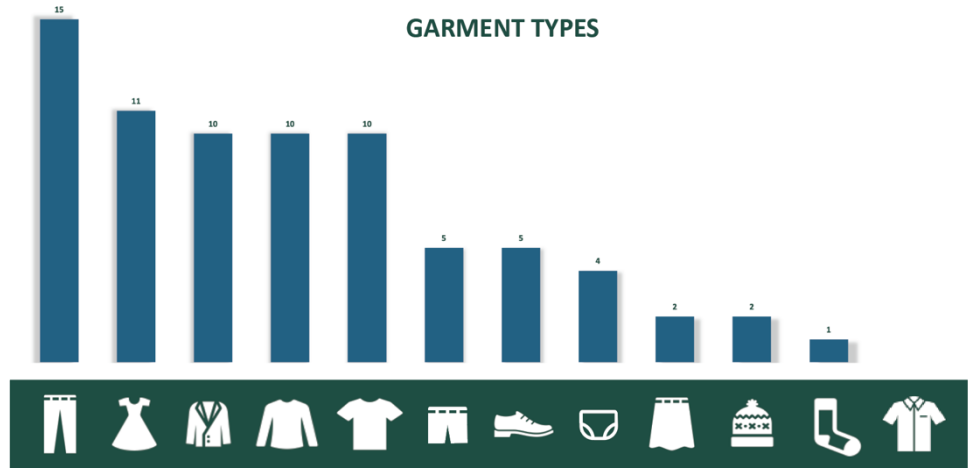
Respondent number	Gender	Age	Yearly household income (DKK)	House size (m2)	Wardrobe size (item count)
1	Female	31	250 – 400K	55	235
2	Female	57	More than 700K	90	194
3	Female	50	250 – 400K	92	655
4	Female	56	More than 700K	140	<b>841</b>
5	Female	56	More than 700K	150	346
6	Male	25	100 – 250K	45	<b>87</b>
7	Male	29	250 – 400K	35	106
8	Female	64	400 – 550K	89	588
9	Female	58	400 – 550K	137	721
10	Female	63	400 – 550K	129	472
11	Male	34	400 – 550K	90	280
12	Male	57	More than 700K	156	328
13	Female	26	400 – 550K	73	371
14	Male	37	400 – 550K	73	249
15	Female	35	550 – 700K	180	328
16	Female	26	100 – 250K	30	375
17	Male	52	250 – 400K	156	361
18	Male	50	More than 700K	106	375
19	Male	52	More than 700K	106	412
20	Male	64	More than 700K	164	701
21	Male	58	More than 700K	85	549
22	Male	58	More than 700K	105	178
23	Female	40	100 – 250K	140	608
24	Male	24	250 – 400K	70	144

### 3.2 OVERVIEW OF PARTICIPANTS' WARDROBE SIZE AND DISTRIBUTION OF ITEMS

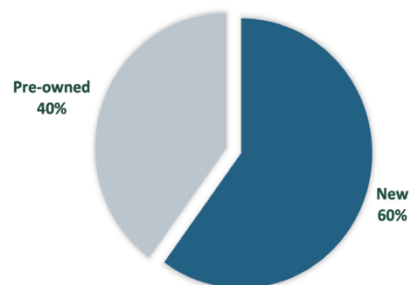
RN	Gender	Age	Total	Foot- wear	Acces- sories	Coats	Trou- sers	Shorts	Skirts	Dres- ses	T- shirts	Shirts	Swea- ters	Under- wear	Socks	Other
1	Female	31	235	14	8	10	21	10	6	21	44	3	28	43	25	2
2	Female	57	194	5	28	3	13	9	1	25	12	4	9	45	36	4
3	Female	50	655	29	62	32	38	11	14	48	96	19	23	98	180	5
4	Female	56	841	45	80	32	47	8	8	105	74	44	71	127	200	0
5	Female	56	346	22	26	19	30	1	7	16	54	15	21	55	75	5
6	Male	25	87	4	7	2	8	5	0	0	20	0	3	17	20	1
7	Male	29	106	7	5	7	7	1	0	0	14	4	8	23	30	0
8	Female	64	588	45	63	29	32	11	12	40	86	29	41	47	148	5
9	Female	58	721	34	121	69	87	0	31	97	45	54	25	51	102	5
10	Female	63	472	23	86	30	21	13	15	52	82	48	24	41	25	12
11	Male	34	280	14	11	13	23	31	0	0	73	17	25	17	56	0
12	Male	57	328	28	58	42	41	9	0	0	32	30	15	21	49	3
13	Female	26	371	16	49	8	29	5	6	22	64	15	21	62	63	11
14	Male	37	249	16	47	12	14	12	0	0	43	12	8	17	65	3
15	Female	35	328	13	35	14	22	11	9	26	39	6	17	62	61	13
16	Female	26	375	21	37	20	30	8	12	5	65	30	23	51	54	19
17	Male	52	361	36	13	22	22	31	0	0	96	32	32	20	53	4
18	Male	50	375	35	43	32	32	14	0	0	53	42	13	32	69	10
19	Male	52	412	35	69	27	30	15	0	0	68	29	17	42	71	9
20	Male	64	701	51	143	47	62	21	0	0	78	98	29	54	112	6
21	Male	58	549	32	52	29	57	19	0	0	135	41	60	65	53	6
22	Male	58	178	14	24	14	29	5	0	0	30	17	6	11	18	10
23	Female	40	608	31	53	63	54	22	28	44	83	27	52	75	70	6
24	Male	24	144	9	6	9	16	3	0	0	34	4	16	22	24	1

## 10. REGISTRATIONS OF THE INFLOW AND OUTFLOW OF THEIR WARDROBES

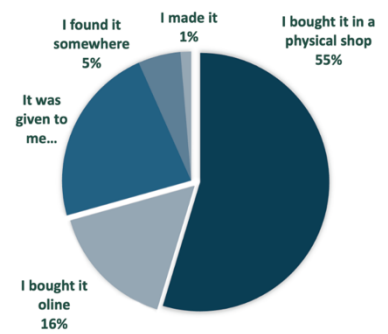
### REGISTRATIONS OF PARTICIPANTS' CLOTHING ACQUISITION



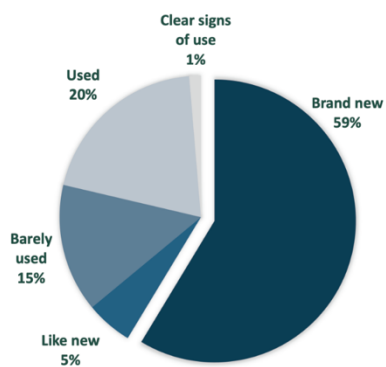
### NEW OR PRE OWNED?



### HOW DID YOU GET IT?



### MATERIAL CONDITION



REGISTRATIONS OF PARTICIPANTS' CLOTHING DISPOSAL

