

Defining Worn Out Workwear: exploring how to assess garments for reuse within a laundry system

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Abstract: This paper explores how to create an objective assessment criterion for ‘worn out’ workwear within an industrial laundry system. Undertaken during the ReSuit project, the research used Elis (laundry service provider) as a case study. Four styles of light workwear (2x t-shirts and 2x trousers) were selected because they represented the products with highest numbers of discards. During a field study, the researchers visually analysed a week’s worth of these discarded garments for a variety of types of wear and tear. The research found that wear and tear could be categorised across four themes: holes, stains, pilling and colour. A traffic light system was created in which garments were assessed as Green: Reusable. Yellow: Normal wear and tear with the potential for reuse. Red: Worn out (discard for recycling). From this assessment guides were created, both digital (to be printed) and physical (exemplars). Working within the limitations of the research, these guides did not provide definitive definitions of worn-out workwear, rather were to ‘start the conversation’ of where the line is drawn between reuse and discard within the workwear sector. This research concludes that there is a huge potential for the workwear sector to reuse clothing and extend the lives of the products and further research should seek to streamline and test this worn out workwear assessment criteria.

Introduction

According to European Commission (2024) textiles have the fourth highest negative environmental impact after food, housing and mobility. To combat this the Commission is actioning its strategy for Sustainable and Circular Textiles which will, amongst many other focus areas, ensure durable textiles and reverse overconsumption. Therefore, this area has become the focus of many research projects.

This study was conducted as part of the ReSuit project (Recycling Technologies and Sustainable Textile Product Design) between design research at Kolding School of Design and industrial laundry service company Elis. The focus of the work was to explore how to increase the longevity of workwear within Elis’ laundry system.

Workwear

Textiles is a large sector that encompasses fashion, interior, architecture etc... This research focuses on textiles produced for workwear. The workwear consumption in 2015 in Europe was 93,000 tones (Malinverno *et al.*, 2023). It is estimated by WRAP, in their report

in 2012 (cited in Nerup, 2022), that employees who wear work clothes replace 3.25 pieces of clothing per year (based on UK data). This demonstrates the potentially vast volumes that will also be discarded. Concerningly up to 90% of discarded workwear could be sent to landfill (Business in the Community, 2021), although this maybe an overestimation, as research concerning workwear in Switzerland suggest incineration could stand at 41%. However, this is still a significant figure that could be diverted into reuse or recycling (Malinverno *et al.*, 2023). What is clear, supported by Malinverno *et al.* (2023), is the data is lacking in this area and much improvements could be made.

Workwear, is defined by ECAP (2017, p.17) as:

“Garments of simple and typically very durable construction usually in poly/cotton fabrics, including boiler suits and coveralls, bib and brace, coats, jackets and trousers”

As Bundgaard-Nielsen (2025) explains, there is a range of workwear practices. Employees may be given the specific workwear ‘uniform’ they must wear, while others could be given an

allowance to purchase their own. Furthermore, while some companies own/manage their own workwear, others may choose to 'lease' it from professional laundries (Malinverno *et al.*, 2023). In this case the garments are selected by companies from catalogues that are suitable for the laundry system (Bundgaard-Nielsen, 2025). Then, across their lives, the laundries are responsible to supply, wash, repair (if necessary) and discard the garments.

Even within a rental system there are different setups. The workwear could be part of a central pool where employees are sent garments each week but not necessarily the exact same ones. Alternatively they could be personalised to an employee (with a visible/external or invisible/internal name tag), and/or as ECAP (2017) points out can be branded with logos. Importantly, visible personalisation has an impact on whether the garment can be reused. Solutions such as changeable name tags with Velcro have been tested but unfortunately where not fit for purpose (Business in the Community, 2021). However, research is underway to explore how to remove printed brandings/name tags which could offer a solution (Bjørn Thorsen, 2024).

Design for Longevity

Designing for longevity and avoiding textiles being discarded at their current pace is widely explored topic. Cooper *et al.*, (2013) explain that garments are mostly discarded because they no longer look good or no longer fit the user. Furthermore, they clarify that users have different expectations for wear and tear that affect longevity, and discard occurs because colours/shapes go out of style or caring for the garments is done inappropriately. To avoid discarding an garment early, Lerpiniere and Davies (2023) suggest that customers should be given more technical information about the longevity of their garments, such as number of expected washes and the expected appearance across time (i.e. colour fastness and shrinkage) as well as life expectancy (how long the garment is designed to last for). However, in the world of professional work wear for use within a laundry system many (but not all) of these elements are already considered and incorporated.

Longevity and Reuse of Workwear

From a longevity perspective, workwear that is produced for laundry systems is designed with durability in mind. For example, ID® Identity's (2024) pro-wear range, they explain, has reinforced details that will withstand daily wear and tear and are designed to keep their shape and colour wash after wash. In addition, laundry companies can offer repair services to keep the garments in use for longer, however, as Bundgaard-Nielsen (2025), points out this can be limited as the price of a new item might be less expensive than the cost of repair.

The lifetime of a piece of workwear, Nerup (2022) clarifies, depends on the type and situation of use. To truly extend the life of the garment it would need to be used by several different people. However, as the Business in the Community (2021, p.10) report describes:

"a perceived barrier is that employees do not want to be issued with 'someone else's clothing'"

This is supported by Nerup (2022), who illuminates, t-shirts and shirts are only passed on if they are relatively new.

One of the issues is the lack of data collected on how the garments get worn out, why it is discarded and how long the lifespan of product is. Thus, workwear that could be reused is being discarded. For example, when an employee leaves (especially when garments are personally assigned and externally named) or at the end of the textile laundry service contract the textiles have to be discarded (*GPP in Practice*, 2016). However, by changing these practices there is potential for environmental and financial gains if the clothes could be reused and lifespans extended (Nerup, 2022).

Worn Out Textiles

According to the Cambridge Dictionary (2024) the word worn out is defined as something that:

"can no longer be used because it is so old or because it has been damaged by continued use"

In Denmark (the location of this study) textile waste has started to be separately collected. Textile waste is defined by Miljø og Ligestillingsministeriet (2024) as "textiles that others cannot benefit from, e.g. damaged,

holed or stained clothes and textiles” (Google Translate, 02.12.2024). However, while these definitions offer an indication of what ‘worn out’ garments might look like the reality is more of a spectrum. For example, Sunde *et al.* (2023) created five grades of clothing in their picking analyse method for of textiles. This started with Grade 1 where the clothing was not useable at all. Grade 2 was similar to Grade 1, but had the possibility to be saved even though it is “on the brink of ruin” (p.44). Grade 3 has noticeable changes; it is still worn but has only small holes/stains and some discolouration. Grade 4 has minor changes, such as a missing button or fabric thinning. Finally Grade 5 clothing is in perfect condition.

The complexity of assessing textiles has also be explored by Nørup *et al.* (2018). In their research, they produced an assessment criterion for a sorting plant of post-consumer clothing. Here they considered: stitching defects, wear and tear, holes, stains faded/discoloured, paint, over-washed, zipper defect, solo item (previously paired, such as a sock). While they don’t explain what ‘wear and tear’ specifically is, they point out that to properly establish the condition of a textile it is essential to understand:

“which product type it is, where the defect is and how extensive it is and whether the product has more than one defect” (p.12)

In workwear, Nerup (2022) enlightens, clothing is discarded “when it is worn or is no longer presentable” (p.15). Nerup’s study also found, that companies often don’t have any specific guidelines for these conditions (worn out or no longer presentable). Assessments were assumed to be based on experience even though this is very subjective. Thus, she argues:

“It would therefore make sense for the individual company to set up criteria for when a uniform is ‘non-rewearable’, ‘rewearable’ or ‘repair for rewearable’” (p.19).

This is the focus of the paper, using Elis as a case study, the research explores how an assessment criterion can be created to encourage reuse of workwear.

Elis Case Study

Within Elis’ laundry system used workwear is delivered to the laundry and washed, dried and folded before returning to the customers. Products can be flagged by either the customer or laundry staff when attention is required, such as when an item is damaged; an employee requires a different size; or an employee stops working and the item is not needed anymore. These products will either be repaired (if possible) before re-entering the system or sent to the warehouse for re-assessment. Here the workwear is either discarded for recycling or reused, depending on condition (wear and tear) and suitability (such as, if it has a logo it could only be used for another employee within the same company, but if it has no logo it could be used for another customer entirely). A reason code is assigned to all discarded garments which enables data analysis (please note that the reason code is often broad and therefore there could be many reasons for discarded garments within a single code).

The re-assessment of items is conducted by trained staff at the warehouse. The product range is very wide, from outerwear to t-shirts, and the condition varies greatly due to different types of use. In this role there is limited time to assess each product and often an assessment is subjective as there is no specific guidelines (currently) for the different product categories making it very challenging. Therefore, the research objective was to help Elis define ‘worn out’ workwear vs. workwear with an ‘acceptable level of wear and tear’ that could be sent back into the system for the customers to reuse.

Methods

The research consisted of multiple field visits (Burgess, 1984) to Elis Taastrup facility, where the system was first mapped visually to establish waste hotspots (Barthel *et al.*, 2014) and choose a specific focus area. The enquiry was narrowed by centring on the discard code “almindelig slid” which translates to “normal wear and tear” (Google Translate, 17.10.24). Using one year of data of discarded products ELIS identified light workwear as the category with the most discards in which t-shirts and trousers formed the two largest product groups. This was narrowed down to 4 specific styles, 2 t-shirts and 2 trousers, for analysis.

The warehouse sorted out and collected approximately one week's discarded products according to their current method. From this, two of the researchers sorted out the specified t-shirts and trousers. The samples discarded using the code "normal wear and tear" were taken by the design researchers for their study (Table 1).

Table 1. Numbers of 4 specific styles collected, and numbers assessed.

Garment Type	Numbers Collected	Numbers of discarded as "normal wear and tear"
2 styles T-shirts	91	56
2 styles Trousers	310	196

Each t-shirt and pair of trousers was visually assessed, and cuttings were taken of specific 'wear and tear' (see details in the next section). This data was reviewed; common themes were established and used to develop a spectrum (traffic light system) of 'wear and tear'. The findings were used to establish a more objective tool (first draft) with the aim of increasing the levels of reuse in workwear.

Procedure and Findings

The procedure used to assess the workwear was developed by the two researchers that conducted the assessment. First, they listed the four main types of wear and tear they were looking for (Table 2).

Table 2. Four areas for assessment

Types of wear	Detail
Trims & stitching	Is the zipper fragile or brittle? Is the snap button loose? Are the Leg straps loose? Loose stitching?
Colour	Faded overall? Specific areas faded?
Surface	Pilling or fuzziness?
Textile	Thinning of the textile? Condition of textile around trims?

After the researchers had conducted a first, visual assessment, the list was transformed into a worksheet (Figure 1) which was used to systematically assess each garment and cuttings were taken and attached for reference (Figure 2).

CAUSATION CODE: 'WORN OUT'

(årsagskode: 'alm. slid')

Style no.:		Label:	
Pool/Person:	Size/length:		
Wash cycles:	Repair:		
Condition of trimmings: <i>Fragile/brittle/tenuous, loose snap button or loose stitch</i>		Color cut: <i>Overall faded or faded areas</i>	
Surface of textile: <i>Pilling or fuzzing</i>		Condition of textile: <i>Thinning of textile or damaged around trim, hemline</i>	
Other conditions:		Other causes: <i>Assessment failure</i>	

Figure 1. Blank Assessment Worksheet

Each researcher assessed half of the samples. While this way of working has limitations, namely two different subjective assessment results, the researchers overcame this by establishing the criteria together and meeting to discuss throughout the process as well as reviewing the findings together at the end. Once the physical data had been collected, the next stage was to review all the textile cuttings (of all 252 garments). From this, four specific 'wear and tear' themes materialised: holes, stains, pilling and colour. For holes, stains and pilling the size and placement was noted. For colour and pilling the level of 'wear and tear' was discussed. To establish the spectrum of wear and tear, the researchers looked for both the



Figure 2. Assessment of Garments

lowest and highest levels across all four categories, such as the smallest and the largest holes and stains. For these two categories (holes and stains) commonalities in location were also noted. The same was established with colour fading and surface pilling. In addition, other attributes were noted, such as broken and missing trims. For example, specifically on the trousers, the leg straps were often cut out by the customer which would need to be repaired if the trousers were reused.

Based on this review the researchers created their own criterion using a traffic light system.

- **Green:** Reusable (good enough to go back into the system and customer should not notice)
- **Yellow:** Normal wear and tear with the potential for reuse (would require customer buy-in and mind shift)
- **Red:** Worn out (discard for recycling)

The results from this assessment can be seen in Figure 3 and 4 in which 13% t-shirts and 26% trousers could be directly used (5% of these trousers would require a small repair, which is a service that is set up within the laundry system). 50% t-shirts and 35% trousers were assessed as 'yellow' which had some 'wear & tear' but were considered within an acceptable level (9% of these trousers would require a small repair). Finally, 37% t-shirts and 39% trousers were assessed as 'worn out' and ready for recycling (please note: 14% t-shirts and 20% trousers of these numbers were assessed as "should be discarded" but for other reasons not due to "normal wear and tear").

This assessment was materialised as a 'kassationsguide' (Google translated as cassation guide – 02.12.2024). This was defined by the researchers as an assessment guide to assess wear and tear on products with the aim of increasing reuse. The guide was presented in both a digital (that was printed and laminated) and physical (exemplars) form; intended to be used by staff at their workstations (see figure 5, 6 and 7 overleaf). The digital guide indicated the parameters for garments to be sorted into the three traffic light categories. The physical guide used examples of the unacceptable and acceptable levels of wear & tear, such as colour fade and pilling. Furthermore, a plastic disc with four holes sizes was provided to measure holes and stains to assess if they were within the thresholds.

Discussion and Conclusions

Defining when a textile is 'worn out' is subjective. While there could be clear physical markers, such as holes and stains (the focus of this study), these physical traits might not stop a person from wearing an item for an extended period. However, within a system where a quality control has been put in place, defining what 'worn out' is and creating criteria for assessment that encourages reuse is vital.

The assessment guides created were not meant as a definitive definition of what acceptable wear & tear is (the nature of the study conducted by two researchers was subjective in its design). Rather, they were created as a 'conversation starter' to help Elis determine for themselves and on behalf of their customers where the line between reuse and discard lies.

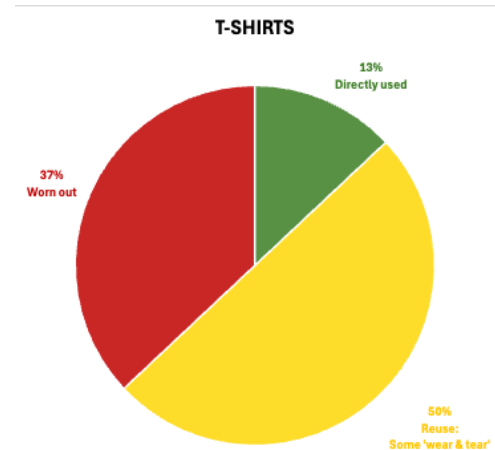


Figure 3. Results of the researcher's assessment – T-shirts.

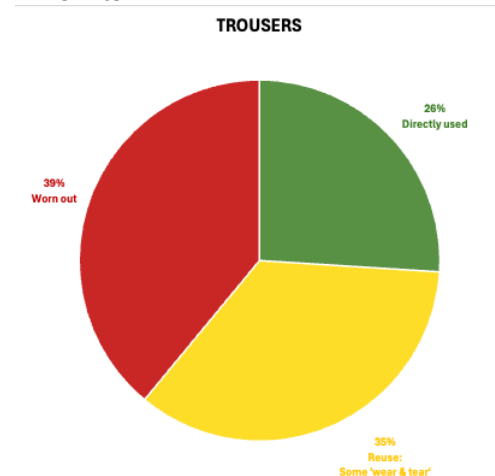
















Figure 4. Results of the researcher's assessment – Trousers

ASSESSMENT GUIDE						
	Holes	Stains	Colour	Pilling		
As new	None	None	None or almost none	None or almost none		
	<div>0</div> <div></div> <div>0,2 cm visible 0,5 cm less visible</div>	<div>0</div> <div></div> <div>0,2 cm visible 0,5 - 1 cm less visible</div>				
Reuse	Small,  location dependent	Small,  location dependent	Uniformly and to a lesser extent	Less visible and to a lesser extent 		
	<div>0,2 cm visible 0,5 cm less visible</div> <div></div> <div>0,2 cm visible 0,5 cm less visible</div>	<div>0,2 cm visible 0,5 - 1 cm less visible</div> <div></div> <div>0,2 cm visible 0,5 - 1 cm less visible</div>				
Kassation	Small or large, location dependent	Small or large, location dependent	Uneven or to a significant extent	Visible or to a significant extent		

Holes & Stains:

 = Location area

Pilling:

 = Location area

T-shirts

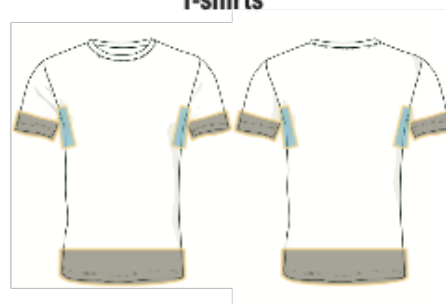


Figure 5. Assessment Guide for worn out workwear t-shirts




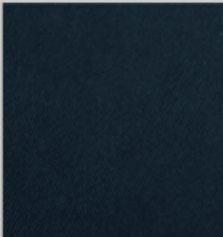






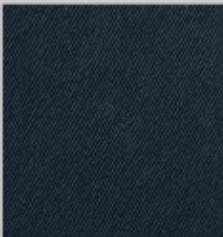



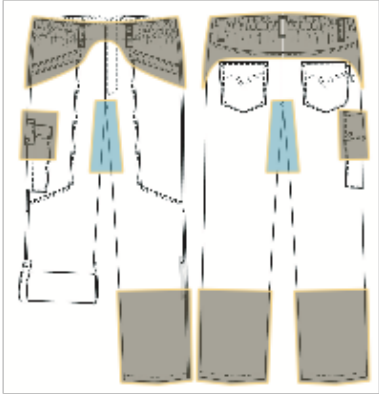
ASSESSMENT GUIDE						
	Holes	Stains	Colour	Pilling		
As new	None	None	None or almost none	None or almost none		
	0  0,2 cm visible 0,5 cm less visible	0  0,2 cm visible 0,5 - 1 cm less visible				
Reuse	Small,  location dependent	Small,  location dependent	Uniformly and to a lesser extent	Less visible and to a lesser extent 		
	0,2 cm visible 0,5 cm less visible  0,2 cm visible 0,5 cm less visible	0,2 cm visible 0,5 - 1 cm less visible  0,2 cm visible 0,5 - 1 cm less visible				
Discard	Small or large, location dependent	Small or large, location dependent	Uneven or to a significant extent	Visible or to a significant extent		
Holes & Stains:  = Location area Pilling:  = Location area					Bukser 	

Figure 6. Assessment Guide for worn out workwear trousers



Figure 7. Physical assessment guide

Following in Nørup *et al.*'s. (2018) suggestion, the sorting guides were specific to garment type and considered the location of acceptable holes, stains and pilling. However, it did not go as far as to consider the number of holes/stains within the guide itself, rather this was assumed know-how that the assessor already possesses. Further research might look to include and or study how the different wear (holes, stains, colour and pilling) interplay with each other and how this effects the assessment.

While the sample used in this study is relatively small (it could be repeated to provide more robust data), it does demonstrate the potential for reuse. If both the 'green' and 'yellow' assessed garments were to re-enter the system, then 63% t-shirts and 61% trousers could avoid being discarded and would prevent the production of new garments thereby reducing environmental impacts and lowering economical costs. However, it should be noted that in order for the garments in the 'yellow' category to be reused a dialogue with the customers would need to take place to help them shift their mindsets to accept more signs of wear. Business in the Community (2021) report suggests that this could be combatted, in part, by the repackaging of the workwear to appear 'new'. However, if the industry is to transition to a circular economy and become more sustainable, then the mindset shift should be bigger and bolder and asking customers to reuse garments that are not new looking, such as with stains. Could this be a badge of honour in this future rather than a mark of bad quality?

The combination of a digital (printed and laminated) and physical (exemplars) guides was considered a successful outcome for

assessment to help staff change their currently very subjective assessment to a more objective one. However, while this study focused on the creation of the guide it didn't go as far as testing it. This will take place in the next stages of the research.

While this guide only focused on t-shirts and trousers that were navy, further research could consider other product categories and colours. We also acknowledge that this guide was created specifically for Elis and while other laundry companies work in similar ways, exploring if this guide is transferable across the industry would expand its impact. Furthermore, future research might consider if this assessment could be translated and/or used as a starting point for assessing discarded clothing/textiles more generally.

Overall, this research concludes that there is a huge potential for the workwear sector to reuse clothing and extend the lives of the products. This study has started a conversation about what 'worn out' is, what levels of use are accepted and provides the groundwork for establishing a practical objective assessment method that encourages the reuse of workwear in the transition to a circular economy.

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- og-industri?PageNum=2&SortBy=Created&SortOrder=DESC&PageSize=8&fg=Category&fg=Certificate&fg=Gender&fg=Size&fg=Color.facets&fg=StyleFit&fg=Composition&fg=Washing&StyleNumber=0302%2c0510%2c0511%2c0322%2c0320%2c0321%2c0362%2c0360%2c0311%2c0383%2c0382%2c0336%2c0326%2c0747%2c0746%2c0745%2c0744%2c0851%2c0850%2c0856%2c0854%2c0913%2c0912%2c0911%2c0910%2c0902%2c0903%2c0385%2c0384%2c0381%2c0600%2c0896%2c0897
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