Extended Abstract
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Analyzing Durability and Failures of Workwear Rain Jackets

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Introduction

Rain jackets are common items included in technical workwear where the user is expected to spend some or most of their time outdoors, with the primary function to keep the wearer dry when working in rainy and wet weather. The form or design of workwear rain jackets is pre-determined based on roles, geographical location, job activities, size and gender and may have specific features such as reflectors, epaulettes, and radio loops. In common with consumer jackets, features such as breathability, waterproofing, and maintenance are important.

The end-of-life for a consumer rain jacket is often determined by wear and tear, functional degradation, design, color and component failure, whereas end-of-life of a workwear rain jacket often occurs at an earlier stage and may mark the end of service rather than an actual end-of-life. For example, features such as retroreflectors, which are common in workwear, are often subject to a maximum number of washing cycles (ISO, 2013). Sometimes, the features of the jacket cause a jacket to be retired early, but the actual garment may still be good to use.

According to the EU Textiles Strategy, by 2030 all textile products placed on the EU market should be durable, repairable, recyclable, and largely made from recycled fibers, free of hazardous substances, and produced in line with social and environmental standards (European Union, 2022). Procurement processes play a key role in the acquisition of rain jackets. The European Union's Green Public Procurement (GPP) for textiles, (Dodd & De Oliveira Gama Caldas, 2017) emphasizes durability and lifespan extension as essential factors in reducing the environmental impact of textiles, setting benchmarks on physical and functional durability.

Durability is particularly important in workwear, as it involves items that are subjected to challenging conditions in professional settings, and rain jackets are especially interesting in this regard as garments with high technical function, and a high purchase cost.

There are currently no universally agreed-upon methods or standards to quantify the durability of textiles, and the debate over how to test and assess durability continues. In this paper, we will consider how procurement processes, failure areas, and the determination of end-of-life workwear rain jackets affect the sustainability, durability and overall performance of these garments.

Methodology

A visual inspection protocol to assess the end-of-life of consumer rain jackets was developed by (Nilsson et al., 2024). In this study, additional criteria related to construction and technical features specific to workwear were incorporated, providing a structured framework for evaluating visible damage in workwear rain jackets. The inspection was performed using a five-point scale, with 1 representing poor, and 5 representing excellent condition.

Observable defects were then correlated with garment performance, through physical tests, including hydrostatic head, air permeability and water repellency measurements. These tests were also used to confirm the presence of a functional defect and its effect on jacket performance.

Results

38 Police rain jackets were collected from three different countries for analysis. The sample sizes varied, with 9 jackets from Country A, 4 from Country B, and 25 from Country C. The sample included 13 jackets with two-layer and lining construction, and 25 jackets with three-layer constructions.

Despite the different constructions of the tested jackets, we observed membrane delamination, as shown in Figure 1, left. Through delamination the garment has lost its primary functionality of waterproofness, and such a defect marks a definitive end-of-life for the product. Reflective elements, commonly present across many garments designed for workwear frequently showed signs of degradation and peeling, such as shown in Figure 1, right, which can be a contributing factor leading to early garment retirement. These garments are often still waterproof, so only part of the total garment functionality is lost, demonstrating the potential to extend service life through improved design.

Comparison criteria	Consumer Rain Jacket	Workwear Rain Jacket
Purchasing scenario	Individual's decision, based on budget and available options	Organizational decision based on tender; garment selected according to list of specifications
Investment in jacket	Involves personal money, knowledge, and trust	Funded by the organization, product is accepted as provided
Emotional connection	Often has an emotional connect	Often lacks emotional attachment
Functional features	Basic additional functional requirements	Requires more features based on job roles, e.g. radio loops and epaulettes
Wash, care and maintenance	Self-organized	Either self-organized or service provided by employer
Determination of end-of-life	Subjective, depends on individual preference	Based on service completion
Quality of product	Varies according to specifications	Fixed quality as per organizational standards

Table 1: A basic comparison of consumer and workwear rain jacket

Hydrostatic head and water repellency tests showed that visual wear did not always correlate with functional loss; some visibly damaged jackets remained waterproof, while others with minimal visible damage failed testing.

Table 1 shows some of the basic contrasts between consumer rain jackets, where the individual is highly invested in the product and workwear rain jackets, which are provided by employers, selected to meet workplace requirements within a predefined budget, and typically lack any emotional attachment from employees. Workwear rain jackets prioritize functional features and must meet fixed quality standards *(Swedish Institute for Standards, SIS, 2019)*

Figure 1-Left: Faded and Peeled Reflector Element | Right: Delaminated Coating

Conclusions:

Estimation of durability is an ongoing challenge in both consumer and workwear domains. This study identified a range of critical and non-critical failures in police rain jackets through visual inspection and physical testing.

We found that the visual inspection results do not always correlate with the physical tests carried out, highlighting that visual inspection alone cannot guarantee jacket performance. Critical failures significantly compromise the jacket's performance; while some of these failures such as broken zippers and sewn reflective elements are repairable or replaceable, they still pose challenges in maintaining the jacket's overall condition. Non-critical failures, while having minimal impact on the jacket's performance, may affect its visual integrity, which may affect its usability in certain roles. Interestingly, some jackets remained waterproof despite visible wear, improving technical specifications and garment design, particularly waterproofing and seam integrity, while repairing and replacing reflectors can enhance durability and reduce premature end-of-life.

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