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Durability as a Factor for Sustainability in the Textile and Clothing Ecosystem: Experiments and system design

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Abstract: Faced with the challenge of the transition to a circular model and the development of innovative biomaterials, it is necessary to reflect on the systemic and sustainable transformation of the textile and clothing industry ecosystem. The omnipresence of design serves as both a unifying force and a catalyst for the substantial advances that are needed in terms of both theoretical and practical knowledge.

In the dual concept of durability, the need emerges to advance technological capabilities that allow a product to resist wear and tear, continuous use, and various environmental factors. This progress involves a multidisciplinary approach that encompasses materials science, textile processing, environmental engineering, biotechnology, and manufacturing systems. However, in its conceptual framework, design transcends these areas, seeking to integrate information technologies and a broad spectrum of social and behavioural sciences. This perspective aims not only to optimise clothing design and the product life cycle but also to forecast their future through critical reflection on material and information flows, using data-supported storytelling.

This article analyses durability as a fundamental factor for sustainability, highlighting its importance in the design of textile and clothing products, as well as its role as an indicator of a product's impact on the circular bioeconomic system. A case study focused on the introduction of bio-based and recycled materials in the Portuguese knitwear industry, namely cotton, lyocell, hemp and a mixture of natural and recycled synthetic fibres, serves to explore and expand knowledge about how the resistance and longevity of these materials affect their life cycle and end of life impact.

Considering the combination of research in different fields, a transdisciplinary methodological approach was essential, using mixed methods to provide a more objective understanding linking the scientific fields of design and textile engineering.

This study examined the relationship between physical durability and design, as well as durability-orientated design. Commercial yarns from companies in northern Portugal were subjected to various laboratory tests to simulate industrial processes and real-life use, including knitting and dyeing, and were afterwards subjected to tests of tear resistance, pilling, colour fastness and washing and drying resilience. Subsequently, the recycling potential and biodegradability were explored as alternatives to disposing of textile waste. Additionally, the study addressed design-led research methodologies science communication strategies mediated by design, thereby contributing to the generation of significant scientific insights in the field of textile and clothing design, both experiential and systemic.

Keywords: Design - durability - sustainability - textile and clothing industry - bioeconomy research projects.

[Resúmenes en español y portugués en la página 228]

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Introduction

The concept of sustainability is becoming increasingly recognised as a multidisciplinary concept that transcends traditional boundaries, emphasising the interconnectedness of economic, environmental, social, and cultural factors (D'Itria, 2022). It is an overarching objective, with sustainable development representing the pathways, strategies, and metrics to achieve it (Jeronen, 2013). Within this framework, sustained growth is essential to balance progress with resource preservation (Barro et al., 2004).
The textile and clothing industry (TCI), as a significant global resource consumer, presents both challenges and opportunities for the implementation of sustainable practices. Initiatives such as the United Nations Sustainable Development Goals (SDGs) and the European Green Deal have developed frameworks to foster resource-efficient and resilient economies (United Nations, 2015; European Commission, 2021). As part of this transition, the TCI has witnessed an evolution towards circular bioeconomy strategies, with a focus on renewable, biobased materials and energy-efficient processes (Textile Exchange, 2022).
The recent literature on the subject makes clear the importance of durability as a sustainability metric within the context of circular design frameworks. The term durability is defined as "the capacity of a product to remain functional and relevant over time under regular use conditions" (Ellen McArthur Foundation, 2020). As it evaluates a product's resilience to wear, usage, and environmental stressors, it enables the product to retain its original characteristics over time [8]. Modern consumer practices, characterised by rapid consumption and disposability, present a significant challenge to the integration of durability within the contemporary economic system [9]. Consequently, an extension of product life cycles directly results in a reduction of the resource demand associated with the production, disposal, and replacement of short-lived goods (Ellen McArthur Foundation, 2021).
New design paradigms present a challenge to established methods, with an emphasis on transdisciplinary approaches to address sustainability in complex systems (Agência Portuguesa do Ambiente (APA), 2021; Collet, 2018). Design has developed from a functional perspective to encompass empathy and systemic change, positioning designers as catalysts for sustainable transformation (Erlhoff & Marshall, 2008; Nold, 2021). In the field of fashion,

systemic design advocates holistic and circularity strategies with the aim of mitigating the ecological footprint (Fashion SEEDS, 2019). Design strategies that prioritise durability, such as the use of high-quality materials, disassembly, and modularity techniques, are becoming increasingly essential for the promotion of sustainable production practices in fashion and textile design (D'Itria, 2022). The importance of bioeconomy-driven approaches in enhancing textile sustainability, by utilising renewable biological resources, is aligned with the principles of circularity and offers innovative opportunities to reduce dependence on non-renewable materials (Collet, 2018; UNECE, 2018). Achieving genuine circularity in textiles is a complex endeavour, particularly in addressing end-of-life scenarios for blended fibres. The limitations of recycling processes highlight the necessity for design strategies that facilitate material recovery, biodegradability, and upcycling (Andersson, 2018). In the European context, initiatives such as the European Action Plan for a Circular Economy and policies targeting textile recycling infrastructure are designed to address these challenges by promoting sustainable resource management (Watson et al., 2018). The expansion of producer responsibility legislation further emphasises the necessity for accountability throughout a product's life cycle, from production to disposal (Foundation, 2022). In response to these challenges, this study employs a transdisciplinary approach integrating design thinking, durability testing, and bioeconomy principles to advance sustainable textile practices. By examining the longevity and recyclability of biobased and synthetic fibres, it contributes to the discourse on durable, circular design in the TCI.

Methodology

This section provides a comprehensive overview of the methodologies, materials and methods utilised throughout the research project, categorised according to the design approaches employed and the laboratory work conducted.

Design approach

This research was conducted by a tailored methodology (Figure 1) that bridges disciplines, combining Research through Design (RtD), Neri Oxman's "Krebs Cycle of Creativity," Design Thinking, and the Scientific Method. RtD positions design as a legitimate scientific inquiry, connecting theory and practice to enrich design solutions (Robbins, 2018). Oxman's cycle models creativity across Science, Engineering, Design, and Art as interwoven, dynamic fields, emphasizing cross-disciplinary transformation and collaboration (Antonelli & Burckhardt, 2020). Design Thinking, renowned for user-centred and empathetic problem-solving, benefits here from integration with the Scientific Method, which adds structured rigor. While Design Thinking excels in ideation, its interactive, open nature can lead to ambiguity; aligning it with the Scientific Method enables critical exploration and quantifiable validation. Together, these methods foster a balanced, adaptable approach, encouraging interdisciplinary creativity and practical, evidence-based outcomes, supporting both innovative thinking and effective problem-solving in complex research challenges (Buchanan, 2019; Britannica, 2023).

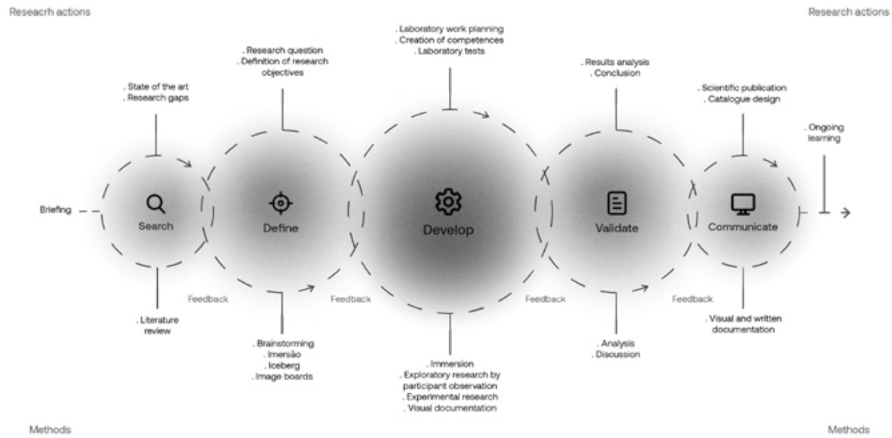

Figure 1. Research methodology.

Experimental development

The following section provides further detail on the materials and methods used in the laboratory work.

- *Materials*

The primary raw materials used in this study included virgin cotton (CO), hemp (CA), and lyocell (CLY) yarns, along with a recycled yarn consisting of 50% wool, 35% polyester, 10% acrylic, and 5% other fibres. In terms of linear density, the cotton and lyocell yarns had a count of Ne 20/1, the hemp yarn was Ne 16/1, and the recycled yarn was Ne 7/1. Both the 100% hemp and 100% lyocell yarns were bleached. Mundifios S.A. and JGomes Lda. kindly supplied the materials used.

- *Methods*

The laboratory development involved a series of steps to simulate the life cycle of a knitted textile product across different processes, enabling accurate durability measurement. This process included: yarn characterisation tests, knitted fabric production, dyeing processes, washing, and drying durability tests, fabric characterisation, biodegradability and recycling simulations, spinning, yarn characterization and final comparative analysis. Each step contributed to a holistic understanding of material performance, resilience, and sustainability impact, providing insights into durability across the textile lifecycle. Detailed descriptions of each step are given in the following subsections.

- *Yarn characterisation*

To establish baseline data for the textile products created, commercial yarns provided were analysed before being subjected to further tests. Physical and mechanical characterizations, including linear density, tenacity, and elongation, were conducted in CITEVE's certified laboratories. The linear density was measured following the NP EN ISO 2060 standard. Tenacity and elongation tests were conducted according to ISO 2062:2009. Tests on cotton, lyocell, and recycled yarns used a Statimat M - Textechno tensile tester with rubber-coated flat grips, while hemp yarns were tested using an Adamel tester with similar grips. Tests were performed in a conditioned environment of 20 ± 2°C and 65 ± 4% RH. The distance between grips was set at 500 mm, the testing speed at 500 mm/min, and pre-tension at 0.5 cN/tex.

- *Knitting process*

The knitting process used the *Tricolab* equipment, a circular knitting machine, laboratory scale, with a 14-needle set per inch. Approximately 30 meters of fabric were produced for each raw material.

- *Dyeing*

The dyeing process was performed only on cotton, hemp, and lyocell knits. Due to staining incidents on lyocell knits, the dyeing process was repeated. The pre-dyeing process included bleaching (for cotton only, as hemp and lyocell were pre-bleached by suppliers), pH adjustment, and hydrogen peroxide removal. Dyeing, pH adjustment, and soap washing followed.

- *Washing and drying tests*

A 30-cycle washing and drying process was carried out to simulate typical textile product use by consumers, with the aim of measuring durability factors under wet treatment conditions using a standard washing machine and tumble dryer.

- *Fabric Characterization*

The knitted fabrics were evaluated based on their colour fastness, dimensional stability, breaking strength and elongation, as well as their resistance to pilling.

The colorimetric characteristics of the knits were quantified utilising a Spectraflash® SF250 spectrophotometer. The CIELab colour system was employed to calculate differences against a defined standard sample (ΔE^*). Tests were conducted on the control sample and at 1, 2, 3, 4, 5, 10, 20, and 30 washing cycles.

The dimensional changes in cotton, hemp, lyocell, and recycled knits were evaluated over the course of 1, 2, 3, 4, 5, 10, 20, and 30 washing cycles. A rectangular marking, measuring 6 x 4 cm, was applied to each sample in order to facilitate the tracking of any shrinkage or elongation change in relation to the control sample.

The breaking strength and elongation test (strip method) was conducted in accordance with the standards set forth in ISO 13934-1:2013. The mechanical resistance of the knits was evaluated through tensile testing, employing the CRE Tensile Olsen apparatus to ascertain the maximum force and elongation each sample could withstand. Samples from the control group and the group that underwent 30 washing cycles were submitted for testing.
The pilling resistance was evaluated in accordance with the standards set forth in EN ISO 12945-2:2020, utilising the Martindale device. The assessment was conducted on both the control sample and those subjected to 5, 10, 20, and 30 washing cycles. In order to assess the pilling resistance, a 100% cotton fabric was used in place of the abrasion blades. The results were recorded on a scale of 1 to 5, with 1 indicating a dense surface fuzz and severe pilling and 5 indicating no change. The evaluations were conducted at 125, 500, 1,000, and 2,000 cycles.

- *Mechanical Recycling*

The initial stage in producing yarn from recycled materials at CITEVE involved cutting and defibrillation. Using the Starcut 500, a rotating blade cutting machine, material width and drum passes were adjusted, though hand-cutting was necessary due to equipment malfunction. Defibrillation was conducted with the Cadette model, a five-module machine, where parameters such as belt speed, cylinder rotation, and roller feed speed were controlled for optimal fibre separation.
For spinning, conventional ring-spinning methods were applied using the Mesdan laboratory line, which includes a carding machine, drafting unit, ring spinner, and winder. This study focused on understanding variables across the process and the integration of 50% virgin cotton with 50% recycled fibre to maintain textile standards. Due to contamination, CLY fibre was excluded from recycling.
Yarn title (linear density) was determined per EN ISO 2060:1995, adapted to 1 m length due to sample limitations. Mechanical tests on recycled yarns followed ISO 2062:2009 using Statimat M – Textechno under controlled temperature and humidity.

- *Biodegradability*

In order to evaluate the potential end-of-life applications of the cotton, hemp, lyocell, and recycled knits, biodegradability tests were conducted. In accordance with the ISO 20200:2015 standard, the tests were conducted by the CITEVE microbiology laboratory, which analysed samples both before and after the simulation of consumer usage. Samples measuring 10 x 20 cm were subjected to a soaking process in distilled water and subsequently buried in organic compost within distinct reactors. Subsequently, the samples were subjected to a 58°C greenhouse period of 30 days, with samples retrieved on days 15 and 30. The reactors were weighed and watered every day until day 15 and every two days thereafter.

Results

This section delves into the results obtained from the laboratory work setting as well as their implications for design applications.

Experiments

- *Colour* fastness

The figure below (Figure 2) illustrates the results of the colour fastness tests. The results compare the different raw materials submitted to the study in relation to wash and dry cycles.

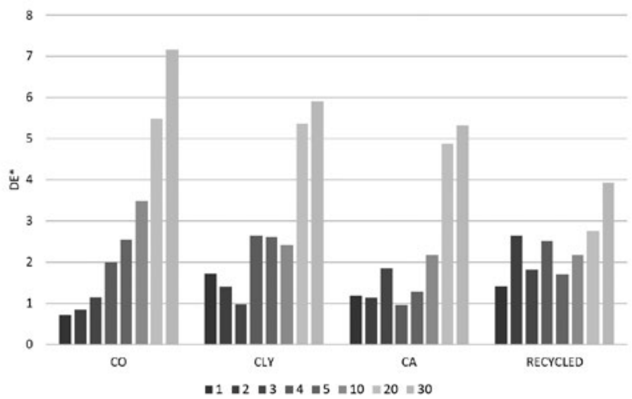

Figure 2. Colour difference results in CO, CA, CLY, and RECYCLED samples.

The results of the colour coordinates indicate that cotton knitwear exhibits the most significant deviation from the standard colour with increasing washing and drying cycles. The greatest variability in values is observed mainly in recycled yarn knits, which is likely due to the loss of fibrils during the washing/drying process and the diverse range of colours in recycled yarn, which encompasses shades from pink to grey.

- *Dimensional stability*

Figure 3 illustrates the variations in shrinkage percentage observed in the cotton, lyocell, hemp and recycled knits subjected to a range of wash cycles, from 0 to 30 washes.

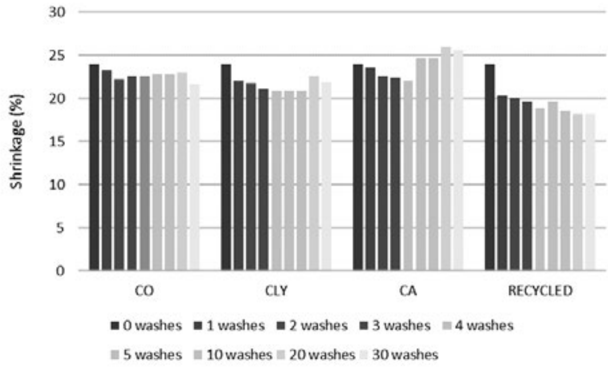

Figure 3. Shrinkage percentage in CO, CLY, CA, and recycled knits after 0 to 30 wash cycles.

It became evident that the wet washing and drying process induces a shrinkage effect in the knitwear, which is subsequently observed during the dyeing process. The extent of shrinkage is notably influenced by the temperature parameters employed in the equipment. The recycled yarn knit exhibited the highest shrinkage rate at 24 per cent, a result attributed to its 50 per cent wool composition. Additionally, hemp was the only knit with a structural elongation of 7 per cent. In contrast, the cotton and lyocell knits demonstrate a similar pattern, consistently following a contraction and subsequent expansion curve in the shrinkage domain.

- *Breaking strength and elongation*

As shown in Figure (4) below, the results of mechanical resistance tests (strip method).
The washing and drying cycles were observed to result in an increase in the average value of the applied force, as well as the elongation before rupture, in comparison to the control sample. However, given the limited number of test samples (five samples per composition), no significant increases were reported, and no definitive conclusions could be drawn.

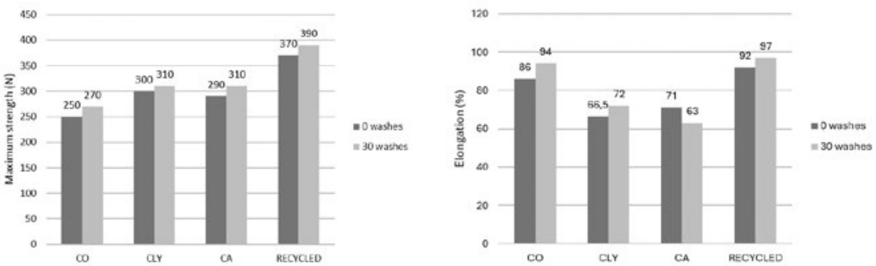

Figure 4. Comparison of maximum strength and elongation
in knitted samples before and after 30 washes.

- *Pilling resistance*

The data presented in Figure 5 illustrates the resilience of the compared raw materials after 30 cycles of washing and drying under conditions simulating real-world use.

CO	Pilling			
	125	500	1000	2000
0 washes	4-5	4-5	4-5	4
5 washes	4	4	4	4
10 washes	4-5	4-5	4-5	4-5
20 washes	4-5	4-5	4-5	4-5
30 washes	4-5	4-5	4-5	4-5

CLY	Pilling			
	125	500	1000	2000
0 washes	3	2-3	2	2
5 washes	2-3	2	2	2
10 washes	2-3	2-3	2	1-2
20 washes	2-3	2-3	2	2
30 washes	3	3	2-3	2-3

CA	Pilling			
	125	500	1000	2000
0 washes	4-5	4-5	4-5	4
5 washes	4-5	4	3-4	3
10 washes	4	3-4	3-4	3
20 washes	3-4	3	3	2-3
30 washes	3	3	2-3	2

RECYCLED	Pilling			
	125	500	1000	2000
0 washes	4	4	4	4
5 washes	4	3-4	3-4	3
10 washes	3-4	3	2-3	2-3
20 washes	3-4	3	2-3	2
30 washes	4-5	4	3-4	3

Figure 5. Pilling test results.

In consideration of the presented results regarding pilling resistance, it is evident that lyocell exhibits the highest level of anticipated pilling among the samples. Cotton is identified as the most resistant raw material, in stark contrast to hemp, which shows a notable tendency for pilling throughout its utilisation. Additionally, the pilling behaviour of recycled knitwear may exhibit greater variability due to its composition of wool and synthetic fibres.

- *Linear mass, tenancy and elongation*

The results presented in Figure 6 compare the linear density, tenacity, and elongation of both commercial and blended recycled yarns.

In commercial yarns, 100% cotton has the highest linear density, indicating a finer thread, while recycled fibre yarn is the thickest. Lyocell and hemp yarns fall in between, with hemp showing the highest tenacity but lowest elongation, making it highly resistant to breakage but less flexible. Cotton and lyocell have moderate tenacity and elongation, while the recycled yarn has the lowest tenacity, making it less durable.

In blended yarns, a mix of recycled and virgin hemp/cotton produced finer yarn (Ne 18/1) than recycled mixed fibres. However, all blended yarns showed lower tenacity than commercial options. The elongation analysis revealed slight increases in recycled cotton and hemp blends, but a substantial decrease from 12% to 6% in recycled mixed fibres.

In summary, recycled fibres offer moderate performance, with hemp showing promising fineness and strength, but overall lower tenacity in blends compared to commercial yarns, especially in terms of elongation consistency. The lyocell yarns were excluded from consideration due to fibre contamination that occurred during the recycling process.

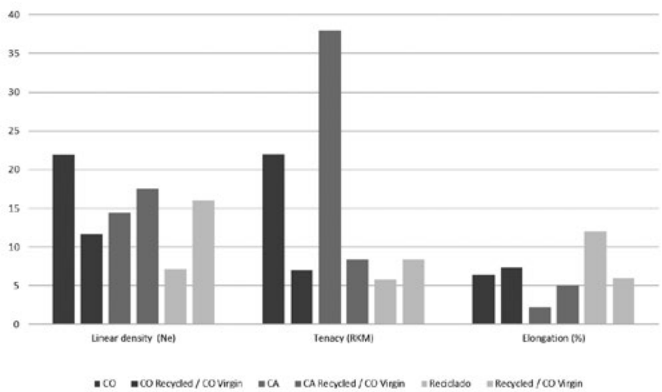

Figure 6. Comparison of linear mass, tenacity, and elongation between commercial yarns and post-consumer recycled yarns.

- *Biodegradability*

The biodegradability tests revealed distinct degradation patterns across different textile materials (Figure 7).

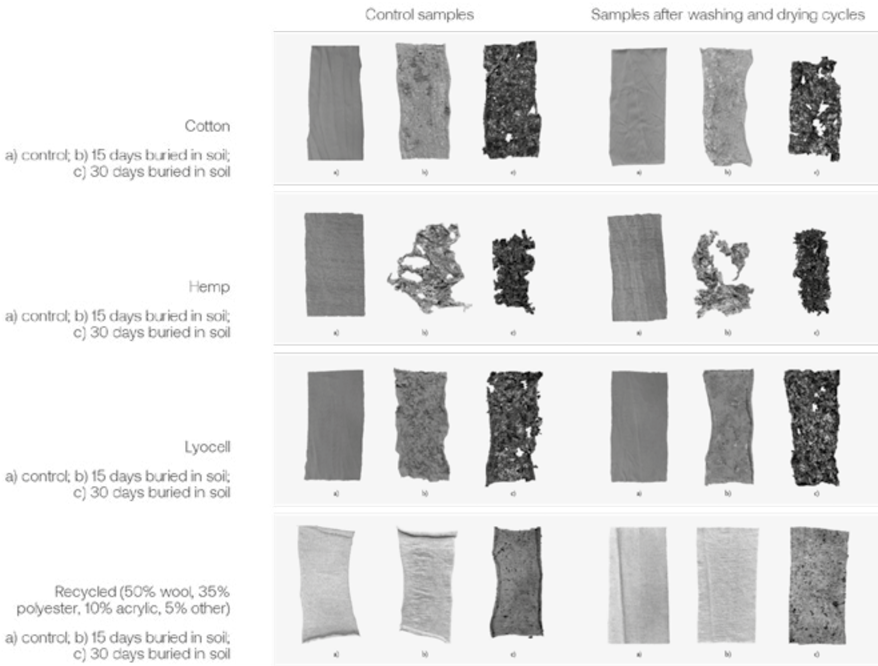

Figure 7. Biodegradability test results.

Cotton samples displayed faster degradation in untreated samples, especially by day 30, showing mould growth and colour fading. Lyocell exhibited fungal growth and uniform colour loss, with the highest degradation observed after 30 days in post-wash samples. Hemp samples showed pronounced degradation with discoloration and fragility, disintegrating upon removal, particularly in unwashed samples. In contrast, recycled fibre samples (50% wool, 35% polyester, 10% acrylic, 5% other) showed no visible degradation but some colour and shine loss. The porosity in hemp likely promoted microorganism activity, while lyocell showed greater resistance compared to cotton and hemp.
Although washing cycles affected degradation, the results did not conclusively indicate their impact. Mass measurements in reactors were inconclusive due to high variability.

Design

- *Problem deconstruction through design*

In order to address the complex problems presented in this study, it was necessary to adopt a systemic approach, as illustrated in Figure 8.

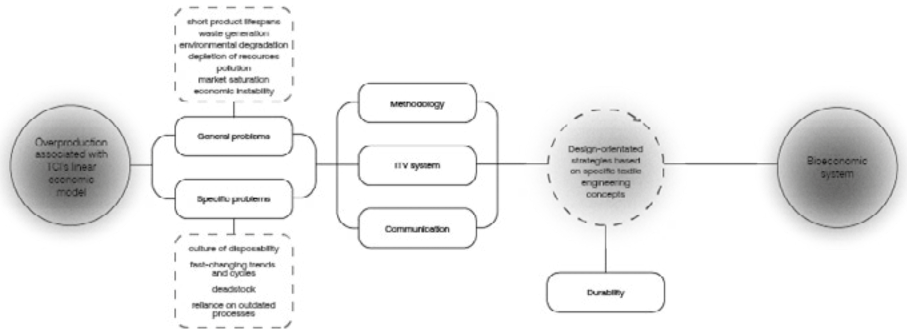

Figure 8. Analysis of research problem using the iceberg model.

The figure illustrates the application of the iceberg model approach, in which problems were deconstructed to create a collaborative framework linking textile engineering and design, with a focus on systems thinking, communication strategies and fashion design. Figure 8 presents a comprehensive analysis of the problem definitions, underlying causes, observable patterns, emerging trends, resource constraints, and potential research-driven solutions, which serve as a reflective foundation for the main project. The key general issues identified include the relatively short product lifespans of many items, the generation of waste, environmental degradation, the depletion of resources, pollution, market saturation, and economic instability. Specific challenges also emerge, such as a prevailing culture of disposability, the fast-changing nature of seasonal trends and cycles, deadstock, and the reliance on outdated processes.

- *Testing Bioeconomic Systems*

The systemic approach to bioeconomic transition was essential for scientifically informed decision-making. Figure 9 illustrates keyways to reassess the physical longevity of textiles made from cotton, lyocell, hemp, or recycled materials. Durability encompasses a product's life from purchase to disposal, shaped by its design and eventual end-of-life or reuse potential. Laboratory testing was crucial for developing and validating new model designs, focusing not only on economic feasibility but also on physical functionality and environmental impact reduction. To present the results of these systems tests, findings were quantified on a scale of 1 to 3, reflecting the impact of each test on extending the life cycle of the knits, and were assessed on a Technology Readiness Level (TRL) scale for end-of-life solutions. It is important to note that this study did not consider social and cultural factors.

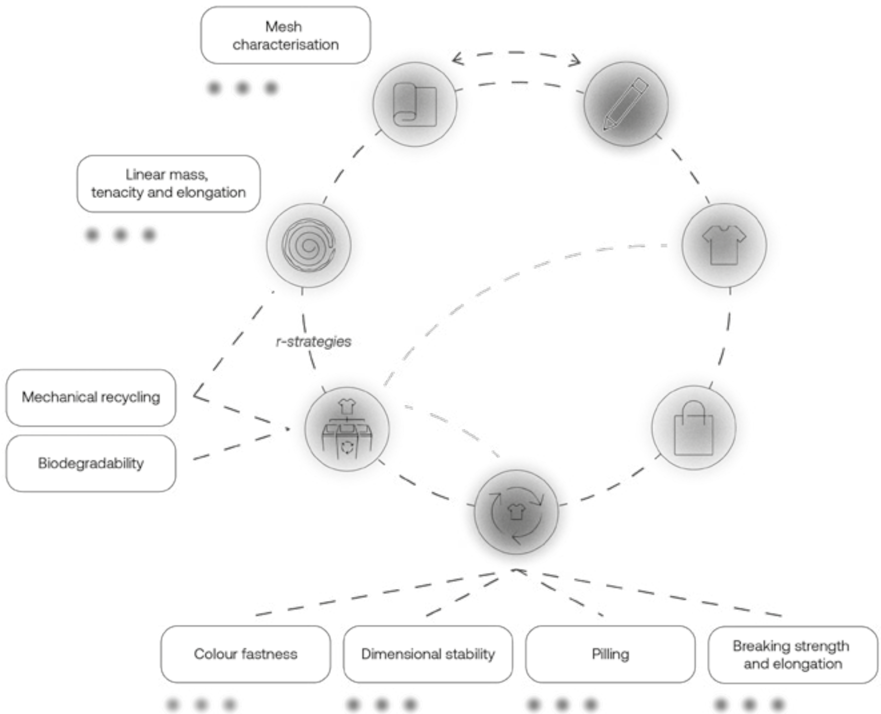

Figure 9. Bioeconomic material systems for circular design.

- *Communicating Science through Design*

Integrating principles of scientific and communication design can broaden the reach of scientific knowledge. Although scientific publications play a crucial role in the academic community, they cater to a very specialized audience. This importance highlights the need for continuous development.

In Portugal, many fashion designers have intermediate qualifications, typically at levels IV and V, with professional, hands-on experience being the primary guiding factor (Faria, 2023).

This makes it essential to create communication tools tailored to this audience, as they are instrumental in developing marketable products.

To support this, a catalogue featuring research samples was produced (Figure 10), along with a short documentary film (https://vimeo.com/1026716462?share) (Figure 11) that captures the process.

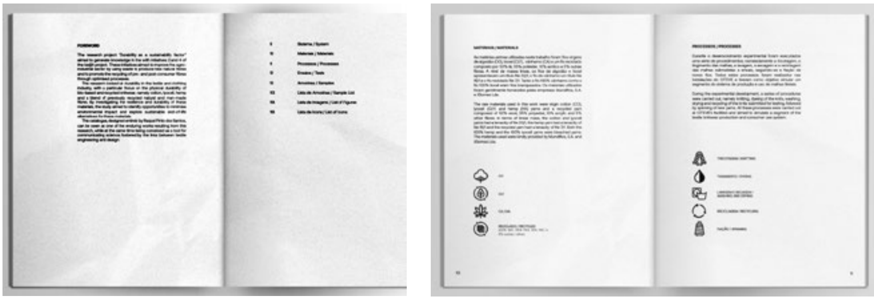

Figure 10. Research samples catalogue preview.

Figure 11. Short documentary about the research.

Conclusions

This study addressed the research gap on durability as a critical sustainability factor in the textile and apparel industry, contributing significantly across multiple domains:
Knowledge Generation, as it supports the advancement of scientific research and the technological capabilities of STV and the be@t project, promoting an integrated engineering-design approach to improve durability and sustainability in textiles (SDG 9);
Sustainable Resource Management, with the contribute to waste reduction and sustainable resource use, promoting circular practices within Portugal's textile sector and encouraging materials that endure (SDG 12);

Climate Resilience, by focusing on durability, the project encourages materials that last, thereby reducing the environmental impact of frequent replacements (SDG 13);
Collaborative Knowledge Development, as it fosters interdisciplinary collaboration, benefiting all stakeholders involved and promoting a holistic approach to textile production (SDG 17).
In engineering, while sourcing these fibres may still pose implementation challenges, the study shows that durability extends product life cycles, reducing production rates and waste. This shift allows companies to focus on high-value, durable materials, encouraging consumers toward more sustainable choices and fewer purchases over time. Exploring lower-impact, end-of-life solutions for biobased and recycled knits revealed promising alternatives: hemp offers strong biodegradability, while cotton and lyocell knits may benefit from high-value reuse strategies. Recycled knits show high recycling potential due to their degradation resistance, though fibre blending presents challenges.
The design approach provided a collaborative framework that integrates textile engineering and design, emphasizing a systemic perspective for informed decisions on product longevity. This study highlights the importance of social and cultural considerations alongside technical aspects, with science communication through design, such as catalogues and videos, broadening industry knowledge.
In conclusion, this research reinforces the role of durability as a key sustainability indicator, showcasing the powerful synergy between design and textile engineering.

Acknowledgements

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Resumen: Ante el reto de la transición hacia un modelo circular y el desarrollo de biomateriales innovadores, es necesario reflexionar sobre la transformación sistémica y sostenible del ecosistema de la industria textil y de la confección. La omnipresencia del diseño sirve a la vez como fuerza aglutinadora y catalizadora de los avances sustanciales que se necesitan en términos de conocimiento tanto teórico como práctico.

En el doble concepto de durabilidad, surge la necesidad de avanzar en capacidades tecnológicas que permitan a un producto resistir el desgaste, el uso continuo y diversos factores ambientales. Este avance implica un enfoque multidisciplinar que abarca la ciencia de los materiales, el procesamiento textil, la ingeniería ambiental, la biotecnología y los sistemas de fabricación. Sin embargo, en su marco conceptual, el diseño trasciende estas áreas, buscando integrar las tecnologías de la información y un amplio espectro de las ciencias sociales y del comportamiento. Esta perspectiva pretende no solo optimizar el diseño de la indumentaria y el ciclo de vida del producto, sino también pronosticar su futuro a través de la reflexión crítica sobre los flujos de materiales e información, utilizando la narración de historias apoyada en datos.

Este artículo analiza la durabilidad como factor fundamental para la sostenibilidad, destacando su importancia en el diseño de productos textiles y de confección, así como su papel como indicador del impacto de un producto en el sistema bioeconómico circular. Un estudio de caso centrado en la introducción de materiales de origen biológico y reciclados en la industria portuguesa de géneros de punto, en concreto algodón, lyocell, cáñamo y una mezcla de fibras sintéticas naturales y recicladas, sirve para explorar y ampliar el conocimiento sobre cómo la resistencia y la longevidad de estos materiales afectan a su ciclo de vida y al impacto al final de su vida útil. Teniendo en cuenta la combinación de investigaciones en diferentes campos, fue esencial un enfoque metodológico transdisciplinario, utilizando métodos mixtos para proporcionar una comprensión más objetiva que vincule los campos científicos del diseño y la ingeniería textil.

Este estudio examinó la relación entre la durabilidad física y el diseño, así como el diseño orientado a la durabilidad. Hilos comerciales de empresas del norte de Portugal se sometieron a varias pruebas de laboratorio para simular procesos industriales y usos reales, incluido el tejido y el teñido, y luego se sometieron a pruebas de resistencia al desgarro, formación de bolitas, solidez del color y resistencia al lavado y secado. Posteriormente, se exploró el potencial de reciclaje y la biodegradabilidad como alternativas a la eliminación de residuos textiles. Además, el estudio abordó metodologías de investigación basadas en el diseño y estrategias de comunicación científica mediadas por el diseño, contribuyendo así a la generación de conocimientos científicos significativos en el campo del diseño textil y de la confección, tanto experienciales como sistémicos.

Palabras clave: Diseño - durabilidad - sostenibilidad - industria textil y de la confección - proyectos de investigación en bioeconomía.

Resumo: Perante o desafio da transição para um modelo circular e do desenvolvimento de biomateriais inovadores, é necessário refletir sobre a transformação sistémica e sustentável do ecossistema da indústria têxtil e do vestuário. A difusão do design serve tanto como uma força unificadora quanto como um catalisador para os avanços substanciais necessários em termos de conhecimento teórico e prático.

No duplo conceito de durabilidade, surge a necessidade de avançar nas capacidades tecnológicas que permitam a um produto resistir ao desgaste, ao uso contínuo e aos

diversos fatores ambientais. Este avanço envolve uma abordagem multidisciplinar que abrange ciência de materiais, processamento têxtil, engenharia ambiental, biotecnologia e sistemas de fabricação. Contudo, no seu quadro conceptual, o design transcende estas áreas, procurando integrar as tecnologias de informação e um amplo espectro de ciências sociais e comportamentais. Esta perspetiva visa não só otimizar o design do vestuário e o ciclo de vida do produto, mas também prever o seu futuro através da reflexão crítica sobre os fluxos de materiais e de informação, recorrendo a histórias apoiadas em dados.
Este artigo analisa a durabilidade como fator fundamental para a sustentabilidade, destacando a sua importância no design de produtos têxteis e de vestuário, bem como o seu papel como indicador do impacto de um produto no sistema bioeconómico circular. Um estudo de caso centrado na introdução de materiais de base biológica e reciclados na indústria portuguesa de malhas, nomeadamente algodão, liocel, cânhamo e uma mistura de fibras sintéticas naturais e recicladas, serve para explorar e expandir o conhecimento sobre como a resistência e longevidade destes materiais afeta seu ciclo de vida e impacto no final de sua vida útil. Considerando a combinação de investigação em diferentes áreas, foi essencial uma abordagem metodológica transdisciplinar, utilizando métodos mistos para proporcionar uma compreensão mais objectiva ligando as áreas científicas do design têxtil e da engenharia.
Este estudo examinou a relação entre durabilidade física e design, bem como design orientado para durabilidade. Os fios comerciais de empresas do norte de Portugal foram submetidos a vários testes laboratoriais para simular processos e utilizações industriais reais, incluindo tecelagem e tingimento, e foram posteriormente testados quanto à resistência ao rasgo, pilling, solidez da cor e resistência à lavagem e secagem. Posteriormente, o potencial de reciclagem e a biodegradabilidade foram explorados como alternativas ao descarte de resíduos têxteis.
Além disso, o estudo abordou metodologias de investigação baseadas no design e estratégias de comunicação científica mediadas pelo design, contribuindo assim para a geração de conhecimento científico significativo na área do design têxtil e de vestuário, tanto experiencial como sistémico.

Palavras-chave: Design - durabilidade - sustentabilidade - indústria têxtil e de vestuário - projetos de pesquisa em bioeconomia.

[Las traducciones de los abstracts fueron supervisadas por el autor de cada artículo.]