

HoliTexCycle - A holistic approach for a product related longevity scheme and multi stage clustering in circular development

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Introduction

The textile and clothing industry is among the most resource-intensive and environmentally burdensome sectors globally. Increasing production volumes combined with shortened product lifespans have amplified material waste and environmental pollution. Transitioning toward a sustainable system therefore requires the adoption of circular design principles that emphasize durability, reparability, reuse, and recyclability. Yet, the implementation of these principles remains constrained by fragmented terminology and the absence of standardized, product-specific frameworks. HoliTexCycle addresses this gap by developing a conceptual framework to guide circular textile design on a product level. The project focuses on establishing a consistent understanding of longevity and circularity across different clothing and textile categories. It aims to integrate technical, functional, and emotional aspects of durability, enabling a more comprehensive assessment of product performance over time. This poster introduces two core components from the initial phase of the research: a longevity scheme that maps the diverse determinants influencing product lifespan, and a multi-stage clustering model that categorizes textile products according to use intensity, function, and material composition. Together, these conceptual tools contribute to operationalizing circularity in textile development and provide a structured basis for aligning design strategies with future sustainability standards and regulatory frameworks.

Methodology

The methodological approach followed a structured sequence of literature synthesis, policy review, and practice-based model development. A systematic literature review of scientific and grey sources on circular textile design, product longevity, and material durability provided the conceptual basis for identifying key determinants of lifespan and recyclability. Parallel analyses of European and national policy frameworks ensured terminological and methodological consistency with current regulatory developments. Based on this foundation, relevant product groups were derived from existing typologies and classification systems documented in research and policy reports. For the further subdivision into product clusters, practice-oriented examples and industry references were examined to capture characteristic material configurations, functional requirements, and user contexts. This iterative process resulted in a multi-level model that links empirical product knowledge with conceptual clarity, serving as a transferable framework for product-specific circularity strategies.

Results

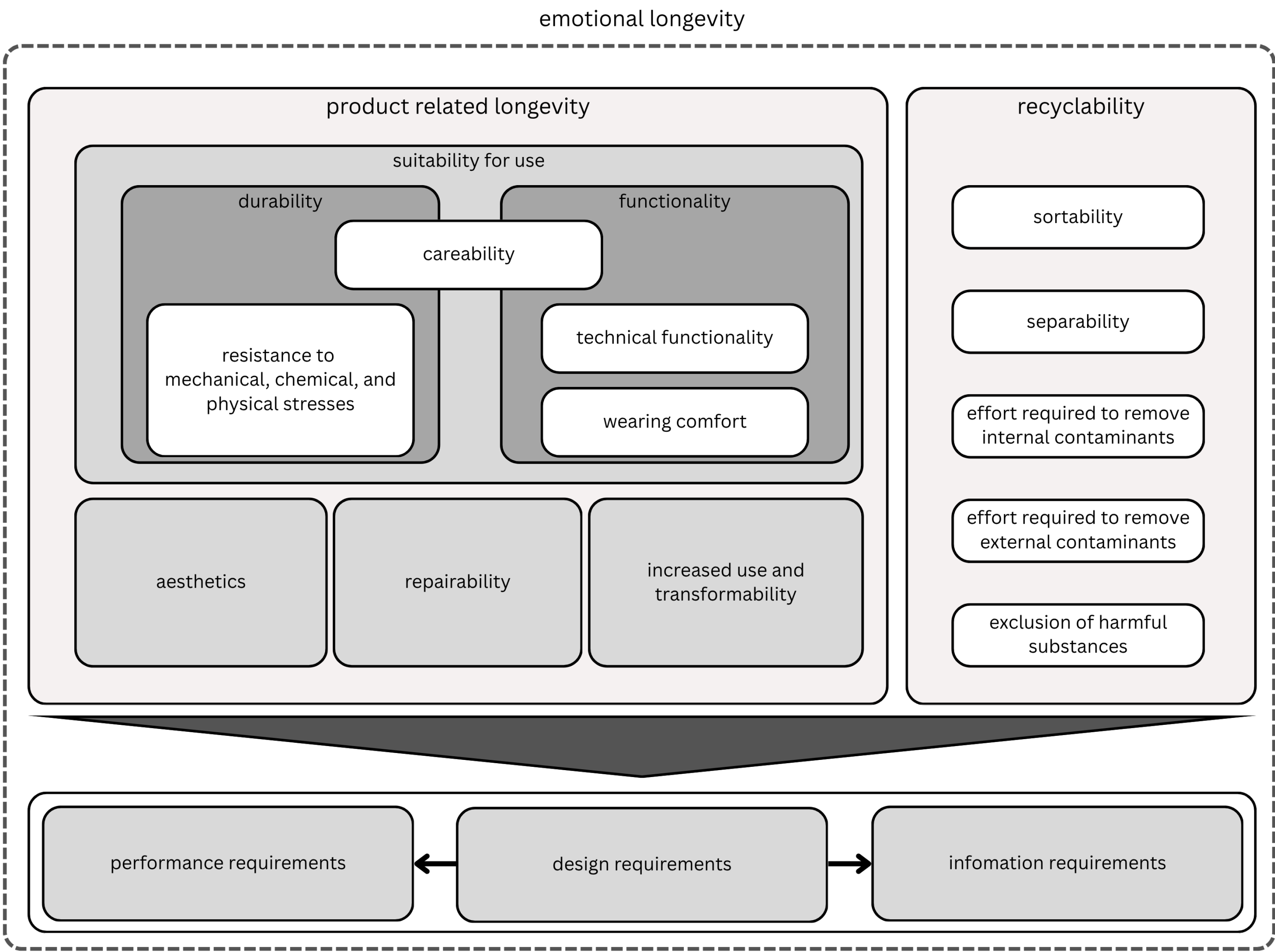


Figure 1: product related longevity scheme

The longevity scheme establishes a differentiated model linking product-related durability, recyclability, and emotional attachment as core dimensions of circular textile design. Product-related durability integrates physical robustness, functionality, and maintainability as prerequisites for extending technical and functional lifetime [1; 2].

Recyclability is defined through sortability, separability, and material purity, ensuring efficient recovery and minimizing contamination risks [3]. Emotional durability emphasizes the user-product relationship and its role in prolonging use intensity and service life [4].

The scheme illustrates that strategies for longevity and recyclability are complementary but interdependent: increasing physical durability may hinder material recovery, while higher recyclability can compromise product lifespan. Effective circular design therefore requires balanced trade-offs, supported by clear design criteria and transparent information requirements [2; 5; 6]

Discussion

The framework provides a conceptual and methodological foundation for translating circular design principles into product-specific applications. By linking technical, functional, and emotional dimensions of longevity with a differentiated product clustering, it enables a systematic understanding of how design decisions affect the durability and recyclability of textiles.

The integration of more than twenty categorical parameters across product types, seasonal and genre contexts, and technical specifications demonstrates the complexity required to operationalize circularity at the product level. This differentiation allows for the development of tailored test protocols, design guidelines, and performance criteria that reflect real product diversity rather than generic assumptions.

Summary

In summary, the model contributes to bridging conceptual circularity with practical implementation in textile design and assessment. It supports future work on standardization, regulatory alignment, and the definition of measurable indicators for product longevity and circular performance, by providing both conceptual clarity and structured applicability.

The clustering model establishes a structured, multi-level framework for differentiating textile and clothing products according to their use context, functional demands, and material composition.



Figure 2: 11 identified product types for cluster level 1

This systematic approach enables a consistent evaluation of product-group-specific design strategies for durability and recyclability. At the first cluster level, a set of eleven product types defines the foundational structure of the model as shown in figure 2. This differentiation captures the diversity of clothing and textile products relevant to circular design considerations and provides a robust basis for product-specific assessment and comparison.

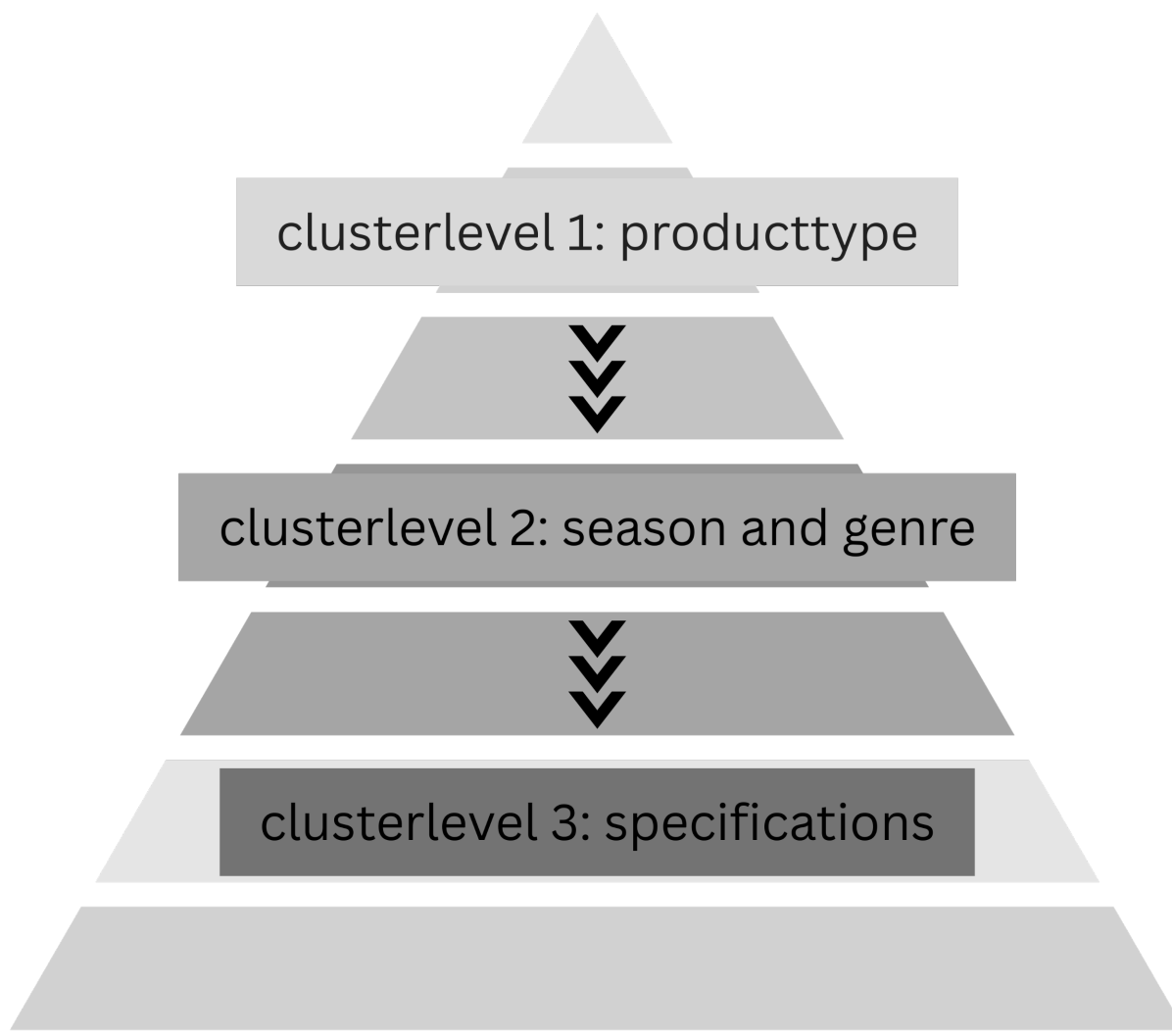


Figure 3: multi stage approach for product clusters

At the third level, the model operationalizes product differentiation through six specification fields that encompass material composition, surface structure, finishing, functionality, closures and inserts, and decorative elements. These parameters cover a wide range of technical and design characteristics, such as the use of cotton, wool, or synthetic fibers; woven, knitted, or laminated constructions; easy-care and non-iron finishes; or design features such as embroidery, prints, and trimmings. Each cluster combines these specifications with targeted design and testing recommendations that translate circular design principles into concrete application contexts

The second level situates these product types within their temporal and functional context through two seasonal classifications, spring/summer and autumn/winter, and five genre categories comprising everyday clothing, outdoor clothing, sportswear, businesswear, and evening wear. These distinctions reflect differences in climatic requirements, aesthetic orientation, and expected lifespan, thereby linking product function, usage intensity, and environmental exposure in a coherent analytical structure.

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