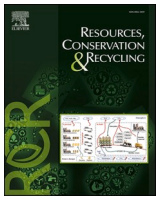
Resources, Conservation & Recycling 225 (2026) 108617

Contents lists available at ScienceDirect

Resources, Conservation & Recycling

journal homepage: www.sciencedirect.com/journal/resources-conservation-and-recycling



Editorial

Editorial: Product lifetimes and the environment: Retaining product value in a circular economy

Extending product lifetimes is central to advancing the Circular Economy (CE), as it enables the retention of value for both first and successive users (Geissdoerfer et al. (2017). Yet in many consumer markets, products are still prematurely replaced—whether due to loss of functional value or other, often subjective, perceptions of diminished worth (Magnier and Mugge, 2022). Many of these discarded products fail to enter reuse markets, leading to significant value loss and exacerbating environmental pressures such as CO_2 emissions, material depletion, and e-waste (Bakker et al., 2014).

The fifth Product Lifetimes and the Environment Conference (PLATE 2023) brought together researchers and practitioners to deepen understanding of how extending product lifetimes can contribute to a CE . This special issue, a direct outcome of PLATE 2023, compiles new insights and empirical research that underscore the importance of retaining product value throughout the product life cycle. A key theme across the contributions is the shift away from merely improving recycling systems toward prioritizing inner-loop strategies—reuse, repair, refurbishment—and systemic lifetime extension.

This special issue covers diverse product categories—ranging from ICT and fashion to children's goods and electric vehicle batteries—and examines value retention from multiple disciplinary and stakeholder perspectives, including design, business, policy, and environmental assessment. The 24 included articles are organized under six thematic sections: 1) Organisational perspective to circular value retention; 2) Longevity in fashion; 3) Changing consumer behaviors for longevity; 4) Design for longevity tools; 5) Policies and eco-systems for longevity; and 6) Environmental impact assessment of longevity. Together, these contributions reflect the state of the art in product lifetime research and provide valuable guidance for academia and practice in navigating the transition to a more circular economy.

1. Organizational perspective to circular value retention

For value retention to become standard practice, businesses must reconfigure how they sell and interact with products. Selvefors et al. (2024) explore how companies are developing user-centered circular value propositions, highlighting tools and strategies used to foster circular consumption. Møller Haase et al. (2024) argue for redefined actor roles across six product life stages to address sources of value loss, offering a blueprint for rethinking products and stakeholder relationships.

Organizational change also involves overcoming internal and external barriers. Løvbak Berg and Hebrok (2024) reveal misalignments between business and consumer perspectives: while companies focus on durability, consumers are more concerned with managing ownership and emotional connections. Similarly, McMahon et al. (2024) explore ICT management within organizations, identifying 13 barriers to circularity and proposing solutions grounded in Lewin's change management model.

2. Longevity in fashion

The fashion sector is emblematic of short product lifespans and high material turnover. Several studies in this special issue focus on how design innovation and consumer practices can lengthen garment life. For instance, Kambanou et al., 2024 investigate construction workwear lifespans under new business models and design strategies, uncovering barriers to success such as poor user acceptance or economic feasibility. Zhang et al., 2024 offer a conceptual framework for modular fashion, arguing that modularity can extend garment use and shift purchasing behaviors.

Fit also plays a pivotal role in garment longevity. Earlier studies have approached fit as an element facilitating emotional connection through aesthetics experiences and wear comfort, but Richardson et al., 2024 show that well-fitting clothes are used more frequently and better maintained, often finding second lives via reuse.

Fast fashion and the current throwaway culture increase the environmental impacts of fashion and accelerate the material throughput in the system. New paths to slow textile use should be considered to tackle these detrimental impacts. Tan and Yeoh (2024) explore textile reuse and repair through a community initiative in Singapore, framing these actions as both circular practices and forms of creative activism.

3. Changing consumer behaviors for longevity

Encouraging consumers to retain products for longer requires an in-depth understanding of the attitudes and behaviors that lead to premature disposal. Six papers in this special issue explore different, yet interconnected aspects of consumer behavior in the Circular Economy, examining how reuse, repair, and care practices can extend product lifetimes.

Consumer perceptions of reuse are multi-faceted, particularly in relation to the resale of pre-owned products and their intrinsic value, with consumers judging different factors, such as aesthetic appearance and condition, functionality and performance as a proxy for remaining lifespan. André & Nilsson (2024) address such critical parameters in their study considering second-hand outdoor jackets. Their findings suggest that because consumers use the appearance of outdoor jackets as a proxy for performance and functionality, perceived subjective functionality and price decline more rapidly than the objective, lab-based measured functionality of such garments. The authors suggest that

https://doi.org/10.1016/j.resconrec.2025.108617
Received 12 September 2025; Accepted 30 September 2025
Available online 10 October 2025

technical testing and labelling of second-hand outdoor garments could overcome barriers to second-hand sales ensuring higher value retention and reducing waste.

Choi & Kennedy's (2024) examine the hibernation of children's products and why they are retained but not reused. Their results suggest that various factors influence hibernation of children's products, such as emotional attachment, imaginaries of future use, environmental concerns and lack of reuse pathways. The study emphasizes the role of care in influencing product retention and suggests the use of design interventions to foster emotional connection, while enabling easier reuse.

Herweyers et al. (2024) consider long-term product reuse, as an alternative to single-use products. Their study identifies willingness, ability, and routine as key factors in ensuring continued use of reusable items, whilst practical barriers such as convenience, hygiene concerns, and social norms often lead to premature discontinuation, despite strong environmental motivations.

Reynolds et al. (2024) discuss the approach effective education can take in helping consumers to adopt product life extension behaviours for domestic appliances. Their results show that consumer education (e.g., via educational messages on care and maintenance of a dishwasher) is an effective tool for increasing resource efficiency and improving product longevity. Lundberg et al. (2024) shift the longevity focus further by considering self-repair, and exploring consumer skills, confidence, and willingness to repair broken products. Their findings show that while people are willing to repair, they often lack the necessary skills, confidence, and incentives. Education, policy support (such as the Right-to-Repair), and product design improvements could help bridge this gap and encourage repair over replacement. Continuing the focus on repair, Lechner et al. (2024) highlight the most important consumer considerations when engaging with professional repair services. Key factors relate to availability of information, economic viability and variability, trust-building and communication. Nevertheless, substantial differences in repair expertise, communication, and product and service were viewed across socio-demographic groups, which may influence consumers' repair behaviours.

Collectively, these studies highlight the complex interplay of perceptual, emotional, practical, and systemic barriers that consumers face when extending product lifetimes. They stress the importance of education, access to information, skill development, and supportive systems in cultivating a culture where products are not only acquired but also actively maintained, repaired, and reused.

4. Design for longevity tools

A central aspect of retaining product value lies in designing products that endure. Yet, design for longevity remains a complex challenge for companies, given the many dimensions and interdependencies involved. Design tools are critical enablers in this process, as they provide guidance, structure, and inspiration during product development. However, the current landscape of such tools is highly diverse and fragmented.

Rexfeldt and Selvfors (2024) review available circular design tools and contribute with a comprehensive overview to help companies navigate. They classify existing tools into five categories, supporting designers to: 1) analyze and prioritize; 2) visualize the flow; 3) draw inspiration from other fields; 4) prompt focus on key aspects; and 5) highlight opportunities.

Three other studies propose new circular design tools to assess and consider lifetime extension aspects. Sierra-Fontalvo et al. (2024) propose a diagnostic tool to access the remanufacture potential at product-component level and integrate remanufacturability knowledge into the early-stage design decisions. They suggest metrics of the 'Disassemblability' (the ability of a product to be dismantled) and the integrity (the physical condition upon return). In a similar vein, Royo et al. (2024) present a design tool for assessing the upgradability and adaptability of design concepts. Encouraging adaptability in products may prolong the product use phase and avoid premature disposal. So, the designer may integrate knowledge from metrics, such as the Standard Design Unit, Function Use Time and frequency of use and rates. In contrast, Özçelik and Löchtefeld (2024) propose a complementary research method to semi-structured interviews, to map and unfold, how industry practitioners consider the lifetime extension aspects of product design, hardware and software in complex products. The study finds token tools may have potential in guiding the conversation and introducing academic concepts to industry practitioners.

Together, these four studies provide a broad overview and focused insights into the current landscape of circular and longevity design tools and contribute to the discussions of how tools-based methods may facilitate: 1) the understanding and integration of measures and metrics in early-stage design, and 2) the interpretation and integration of the manifold interrelated parameters, concepts and tools.

5. Policies and eco-systems for longevity

Policies play a key role in promoting product longevity and restricting premature obsolescence. While policies are increasingly addressing these issues, there is a need to map, analyse and evaluate existing policies, thereby identifying gaps and further improvements. To this end, several articles in this special issue give insight into regulatory shortcomings for different sectors, such as batteries and textiles, where new legislation, particularly in the EU, has recently been implemented or proposed.

Quinteros-Condoretty et al. (2025) propose a conceptual model for extending the lifespan of electric vehicle lithium-ion batteries (LIBs), which identifies that policies for batteries in EU still primarily focus on recycling and that there is a need for stronger incentives for second-life battery applications. Rizos and Urban (2024) examine the drivers and barriers from the perspective of 20 case companies and find that there are inconsistencies in policies, particularly related to waste classification, data-sharing requirements, and cross-border battery transport that hinder second-life applications of batteries in particular. The authors argue the need for greater alignment between policies and the potential for digital product passports to address existing issues. Stefan and Chirumalla (2025) analyse the ecosystem for second-life batteries more broadly, finding that collaboration between different value chain actors is essential for prolonging product lifetimes for batteries, but also that the diversity of different types of actors and the dynamics within the ecosystem need to be considered by policies.

Beyond the battery sector, new policies are emerging for textiles and other products. Based on theoretical and empirical mapping, Puglia et al. (2024) present a novel Circular Policy Canvas as a framework that can be applied to systematically map and study policy mixes. Their application of the canvas framework to the fashion industry reveals policy gaps in promoting product durability and repairability. Similar to the articles examining the battery sector, the authors demonstrate that current policies disproportionately focus on end-of-life recycling rather than durability, repairability, and reuse.

Taken together, these studies underscore the critical role of policy and ecosystems in enabling longevity. They provide not only analyses of current gaps but also frameworks and recommendations to support more holistic, aligned, and forward-looking policy strategies.

6. Environmental impact assessments of longevity

Environmental trade-offs associated with longevity are not always straightforward. Barkhausen et al. (2024) use an integrated Material Flow Analysis (MFA) and Life Cycle Assessment (LCA) framework to assess Circular Economy product policies, and in particular the environmental impacts of extending the lifetimes of products versus replacing them. Their case study on electric motors highlights the complexity of longevity interventions. While early replacement with more efficient models reduces energy consumption, it increases material demand. Conversely, repair extends product lifetime but may result in

suboptimal efficiency gains.

Longevity strategies like repair, refurbishment, and reuse also have social implications. Bhatnagar et al. (2024) review the use of Social Life Cycle Assessment (S-LCA) in evaluating Circular Economy transitions. It finds that most S-LCA studies focus on recycling and energy recovery. In general, S-LCA studies struggle with defining a proper system boundary. Their review calls for a more integrated approach to assess the trade-offs between social and environmental benefits when designing longevity policies.

7. Conclusion

This special issue highlights the multifaceted nature of product lifetime extension, illustrating the technological, behavioral, organizational, and regulatory changes needed to retain value and reduce environmental impact. The articles collectively call for a systemic transition—one in which all actors are engaged in reshaping consumption and production practices toward longer product use. Only through such a transformation can we realize the promise of a truly Circular Economy.

CRediT authorship contribution statement

Ruth Mugge: Writing – original draft, Writing – review & editing, Conceptualization. **Louise Møller Haase:** Conceptualization, Writing – original draft, Writing – review & editing. **Melanie Jaeger-Erben:** Conceptualization, Writing – original draft, Writing – review & editing. **Linda Nhu Laursen:** Conceptualization, Writing – original draft, Writing – review & editing. **Kirsi Niinimäki:** Conceptualization, Writing – original draft, Writing – review & editing. **Jessika Richter:** Conceptualization, Writing – original draft, Writing – review & editing. **Benjamin Sprecher:** Conceptualization, Writing – original draft, Writing – review & editing. **Matthew Watkins:** Conceptualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The guest editors extend their heartfelt gratitude to all the contributing authors and diligent reviewers for their invaluable contributions to this special issue. We would like to sincerely thank Prof. Ming Xu, the Editor-in-Chief of RCR, for their invaluable support in developing the proposal and coordinating the virtual special issue (VSI). Additionally, we are grateful for Prof. Zhi Cao's efforts in editing this concluding piece.

Data availability

No data was used for the research described in the article.

References

André, H., Nilsson, L., 2024. Are second-hand shell jackets better than users think? A comparison of perceived, assessed and measured functionality throughout lifespans. Resour., Conservat. Recycl. 204, 107470.
Bakker, C., Wang, F., Huisman, J., Den Hollander, M., 2014. Products that go round: exploring product life extension through design. J. Clean Prod. 69, 10–16.
Barkhausen, R., Durand, A., Fong, Y.Y., Zeller, V., Rohde, C., 2024. Modeling stock, material and environmental impacts of circular economy product policies. Trade-offs between early replacement and repair of electric motors. Resourc., Conservat. Recycl. 205, 107600.
Berg, L.L., Hebrok, M., 2024. Holding on or letting go: conflicting narratives of product longevity. Resourc., Conservat. Recycl. 210, 107834.
Bhatnagar, A., Härri, A., Levänen, J., Niinimäki, K., 2024. Exploring the role of social life cycle assessment in transition to circular economy: a systematic review. Resourc., Conservat. Recycl. 207, 107702.
Choi, Y.J., Kennedy, B., 2024. Understanding product hibernation periods with children's products and exploring motivations and barriers for product care to encourage their reuse. Resourc., Conservat. Recycl. 205, 107576.
Geissdoerfer, M., Savaget, P., Bocken, N.M., Hultink, E.J., 2017. The Circular Economy–A new sustainability paradigm? J. Clean Prod. 143, 757–768.
Haase, L.M., Mugge, R., Mosgaard, M.A., Bocken, N., Jaeger-Erben, M., Pizzol, M., Jørgensen, M.S., 2024. Who are the value transformers, value co-operators and value gatekeepers? New routes to value preservation in a sufficiency-based circular economy. Resourc., Conservat. Recycl. 204, 107502.
Herweyers, L., Du Bois, E., Moons, I., 2024. Use-clean-repeat: understanding user, product, and context to design for long-term reuse. Resourc., Conservat. Recycl. 204, 107511.
Kambanou, M.L., Matschewsky, J., Carlson, A., 2024. Business models and product designs that prolong the lifetime of construction workwear: success, failure and environmental impacts. Resourc., Conservat. Recycl. 206, 107602.
Lechner, G., Kraßnig, V., Güsser-Fachbach, I., 2024. How can repair businesses improve their service? Consumer priorities concerning operational aspects of repair services. Resour., Conservat. Recycl. 204, 107501.
Lundberg, P., Vainio, A., Viholainen, N., Korsunova, A., 2024. Consumers and self-repair: what do they repair, what skills do they have and what are they willing to learn? Resour. Conservat. Recycl. 206, 107647.
Magnier, L., Mugge, R., 2022. Replaced too soon? An exploration of Western European consumers' replacement of electronic products. Resour. Conservat. Recycl. 185, 106448.
McMahon, K., Mugge, R., Hultink, E.J., 2024. Overcoming barriers to circularity for internal ICT management in organizations: a change management approach. Resour., Conservat. Recycl. 205, 107568.
Özçelik, A., Löchtefeld, M., 2024. Connected product lifetime extension tokens (CPLET): eliciting longevity concepts of connected audio products. Resour., Conservat. Recycl. 208, 107734.
Puglia, M., Parker, L., Clube, R.K., Demirel, P., Aurisicchio, M., 2024. The circular policy canvas: mapping the European Union's policies for a sustainable fashion textiles industry. Resour., Conservat. Recycl. 204, 107459.
Quinteros-Condoretty, A.R., Laukkanen, M., Kainiemi, L., Pinto, S.M., Lourenço, E.J., Oliveira, L., Albareda, L., Barbiellini, B., 2025. Conceptual model for extending electric vehicle battery lifetime. Resour., Conservat. Recycl. 212, 107943.
Rexfelt, O., Selvefors, A., 2024. Mapping the landscape of circular design tools. Resour., Conservat. Recycl. 209, 107783.
Reynolds, M., Salter, N., Muranko, Ż., Nolan, R., Charnley, F., 2024. Product life extension behaviours for electrical appliances in UK households: can consumer education help extend product life amid the cost-of-living crisis? Resour., Conservat. Recycl. 205, 107527.
Richardson, C., Boardman, R., Gill, S., 2024. Exploring clothing fit as a motivator for lifetime extension and circular disposal. Resour., Conservat. Recycl. 204, 107494.
Rizos, V., Urban, P., 2024. Barriers and policy challenges in developing circularity approaches in the EU battery sector: an assessment. Resour., Conservat. Recycl. 209, 107800.
Royo, M., Mulet, E., Chulvi, V., Ruiz-Pastor, L., 2024. A metric for assessing the upgradability and adaptability of circular concepts. Resour., Conservat. Recycl. 205, 107512.
Selvefors, A., Renström, S., Whalen, K.A., Fallahi, S., Leivas, M., Nordenö, H., Fransson, A., 2024. User-centered circular value propositions–approaches in practice and research. Resour., Conservat. Recycl. 207, 107628.
Sierra-Fontalvo, L., Polo-Cardozo, J., Maury-Ramírez, H., Mesa, J.A., 2024. Diagnosing remanufacture potential at product-component level: a disassemblability and integrity approach. Resour., Conservat. Recycl. 205, 107529.
Stefan, I., Chirumalla, K., 2025. Enabling value retention in circular ecosystems for the second life of electric vehicle batteries. Resour., Conservat. Recycl. 212, 107942.
Tan, Q.H., Yeoh, B.S., 2024. The temporal dimensions of textile circularity loops: a community initiative at shortening loops and prolonging textile lives in Singapore. Resour., Conservat. Recycl. 206, 107601.
Zhang, X., Le Normand, A., Yan, S., Wood, J., Henninger, C.E., 2024. What is modular fashion: towards a common definition. Resour., Conservat. Recycl. 204, 107495.

Ruth Mugge[a,*], Louise Møller Haase[b], Melanie Jaeger-Erben[c], Linda Nhu Laursen[d], Kirsi Niinimäki[e], Jessika Richter[f], Benjamin Sprecher[a], Matthew Watkins[g]
[a] *Delft University of Technology, the Netherlands*
[b] *Aarhus University, Denmark*
[c] *Brandenburgische Technische Universität, Germany*
[d] *Aalborg University, Denmark*
[e] *Aalto University, Finland*
[f] *Lund University, Sweden*
[g] *Loughborough University, United Kingdom*

[*] Corresponding author.
E-mail address: r.mugge@tudelft.nl (R. Mugge).