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ORIGINAL PAPER

Circular Value Toolkit: a Novel Route to Value Preservation in a Sufficiency-Based Circular Economy

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Abstract
Companies are pivotal in transitioning from a linear economy to a sufficiency-based circular economy. However, circular research lacks the necessary tools and processes to engage companies, customers, and downstream suppliers in preserving the value of their products post-launch. Effective value preservation requires close collaboration among producing companies and their ecosystem stakeholders to identify when value is decreased or destroyed over the product's lifetime and to develop shared strategies to preserve or increase this value. This paper contributes to the development and empirical evaluation of the Circular Value toolkit. Based on demonstration with 15 SMEs and 24 PhD students, we found that the Circular Value toolkit supports companies in 1) identifying the points in the product lifetime where value is currently decreased or destroyed; 2) developing ideas and concepts to prevent value destruction; and 3) identifying barriers and opportunities for initiating collaboration with ecosystem stakeholders to ensure the efficient preservation of product value throughout the product's lifetime. A valuable next step will be to validate the toolkit's long-term effects and examine its implementation within large organisations.

Keywords Value preserved · Value destroyed · Resource conservation · Sufficiency economy · Sufficiency business

Introduction

The urgency of transitioning from a linear to a sufficiency-based circular economy (SCE) is continuously highlighted in reports on the severe consequences of the current "*take, make, use, and dispose"* economy [1]. The principle of a sufficiency-based economy emphasises the idea of "doing more with less" [1]. This proactive approach prioritises the reuse, maintenance, and repair of products over time while curbing unnecessary consumption [2]. Rather than focusing on maximising production, a sufficiency-based economy shifts towards optimising the use of objects. This involves reducing consumption, extending product lifespans, limiting planned obsolescence, and enhancing product utilisation through strategies such as the sharing economy and product-service systems. It also demands a profound trans-

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formation in business practices, emphasising long-term value creation and regeneration rather than achieving high sales volumes [3, 4]. Hence, a central objective of the SCE is to maintain the value of products and materials at their highest possible level throughout the products' lifetimes. Value preservation efforts suggest that products and their materials are preserved and actively used for a longer period, which reduces resource consumption and limits waste generation, thereby promoting sustainability and environmental stewardship. Thereby, Value preservation distinguishes itself from both value creation and value capture by focusing on the entire lifetime of the product.

In practice, there might be competing or conflicting interests when designing products for value preservation, as companies are oriented towards the economic value of a product [5], while consumers might be more focused on the functional and emotional value of a product. Therefore, we suggest an integrative view of value, encompassing various dimensions. This includes economic value, which highlights the product's value for money [5, 6]. Functional value emphasises the physical performance and utility of the product alongside social value, which reflects the capacity of the product to enhance a social self-concept [6, 7]. And finally, emotional and epistemic value, which refers to the product's ability to evoke emotional responses, such as pleasure or excitement, or contribute to stimulating curiosity and a sense of novelty [8].

Together, these dimensions ensure the product's value is addressed holistically, and we can therefore define "value preservation" as maintaining the economic, functional, social, emotional, and epistemic value of a product at its highest level throughout its lifetime [9].

The integrative view on value aligns with a recent critique of how value is perceived in the linear economy. This critique aims at the ubiquity of economic imperatives of profitability that permeate all spheres of society [10–12] and the dominance of simplistic and one-sided economic value concepts, which either misconceive or ignore social and ecological values [13] like well-being, biodiversity, or the conservation of habitats. Several reports emphasise that a fundamental change in how the world's dominant economies create and distribute value seems inevitable and is now even acknowledged by mainstream economic stakeholders (see, e.g. The World Economic Forum report from 2020). There have been numerous initiatives to incrementally change the misconception of value, like sustainability reporting, environmental labelling, or fair-trade agreements. However, these initiatives stop short of fundamentally transforming the principles of how value is created and perceived [14, 15], a shortcoming we wish to address in this paper through the development of a Circular Value toolkit. With an integrative identification of what kind of value is currently increased, preserved, decreased or destroyed for different partners in the ecosystem, we wish to guide the discussion on value preservation between producers, downstream suppliers and customers [13]. The ambition is that companies will ensure the efficient preservation of the different types of value embedded in the products they market throughout the products' lifetimes.

Companies Focus on the Least Effective Circular Strategies

Currently, transition to CE and SCE can be achieved through circular strategies such as: 1) narrowing the number of new products produced and the amount of materials used for each product *(refuse, rethink, reduce)*; 2) slowing the replacement of products by keeping the product in use for as long as possible *(reuse, repair, refurbish, remanufacture, repurpose)*;

3) closing resource loops ensuring that as much material from one product is used in the next as possible *(recycle, recover)* [16–19]; and 4) regeneration, which focuses on restoring and renewing natural ecosystems [20, 21]. However, several studies indicate that companies are slow to adopt and implement circular strategies. Moreover, they also tend to implement strategies where the least value is preserved. For instance, Prochatzki et al. [22] found that high-quality strategies for reuse are not widely implemented in the industry. Similarly, Ghosh et al. [23] demonstrated that circular initiatives in practice primarily focus on recycling materials because these can be added without changing the existing linear business model. This is problematic because recycling is only a second-order strategy, insufficient to make the needed environmental impact on its own [24]. Instead, reducing demand (narrowing strategy) and reusing products (slowing strategies) must be prioritised first. By adding the concept of value preservation to the circular strategies, this prioritisation becomes evident. It will establish a focus on reusing, repairing, refurbishing, and renewing products (slowing strategies) to maintain the sum of the different values embedded in the product at the highest possible level throughout its lifetime.

Positioning of the Study

Circular innovation research currently lacks the necessary tools and processes to engage companies, customers, and downstream suppliers in maintaining the value of products post-launch (see e.g. [25, 26]). Several tools have been developed to support companies in circular business model innovation; however, few focus on the value chain or the ecosystem. In a literature review, Bocken et al. [27] found that only 5 out of 34 tools focused on the supply chain and/or ecosystem, but none of these include the downstream supply chain (see e.g. [28–31]. Following the review by Bocken et al. from 2019, a few new tools have been developed (see e.g. [18, 32–34]). While these tools improve the level of co-creation and collaboration among stakeholders in the ecosystem, their focus remains on circularity in general and as a result, they do not support companies in shifting focus from the lower R-strategies of reducing materials and recycling towards higher R-strategies and value preservation. The only empirically evaluated tool we identified that focuses on value preservation in ecosystems is the Value Mapping Tool [35]. It provides an important step towards mapping value decrease or loss and has been applied in various contexts [36] but lacks the integration of recent scientific knowledge on SCE and value preservation as provided in [37]. Consequently, the tool lacks targeted support mechanisms to assist companies in their transition toward value preservation initiatives within an ecosystem.

This study addresses this gap by developing a Circular Value toolkit that can facilitate collaboration between producing companies and their downstream suppliers and customers to keep the sum of the economic, functional, social, emotional, and epistemic value of their products at the highest possible level throughout the product's lifetime and into its transition to an SCE. The ambition is that the toolkit will facilitate an integrative perception of value and provide ways to enhance the practices of stakeholders involved in the product lifecycle to not only maximise their value but also consider the values of others. To operationalise this overall objective, we have formulated the following research question:

> ***What does a Circular Value toolkit need to encompass to support companies in 1) identifying points in the product lifetime where value is currently decreased or***

destroyed; 2) developing ideas and concepts to prevent this value decrease or destruction; and 3) identifying barriers and opportunities for initiating collaboration with downstream suppliers and consumers?

The paper is structured accordingly: First, we synthesise value preservation, pattern breaking, and circular ecosystem literature to identify relevant building blocks for the toolkit's development. Second, we develop, demonstrate, and evaluate the toolkit. Finally, we conclude the paper with our findings, limitations, and directions for further research.

Literature Background

Value Preservation and Product Lifetime

The first theoretical building block for the Circular Value toolkit is value preservation. The decline in product value occurs both intentionally and unintentionally. It can be part of a company's obsolescence strategy, but it can also be due to the complexity and misalignment of objectives and actions of various actors and stakeholders that influence the product throughout its lifetime. Therefore, an overview of value changes throughout the product's lifetime is essential. Haase et al. (2024) have identified several factors that negatively impact consumers' perception of product value across five use stages: 1) pre-acquisition, 2) early-use, 3) middle-use, 4) late-use, and 5) pre-disposal and proposed new routes for value preservation. These factors provide central input for the creation of an overview of how value can change throughout the product's lifetime. These are reviewed in Table 1.

Pattern Breaking and New Roles in the Circular Economy

The second theoretical building block for the Circular Value toolkit is pattern breaking. Rivera and Lallmahomed [38] argue that current business thinking, product development practices, and consumer behaviour are heavily influenced by obsolescence strategies. Therefore, to achieve truly circular innovation and an SCE, it is essential to break this existing pattern. Pattern breaking involves challenging and breaking free from established norms to foster creativity and generate novel solutions [39]. This process encompasses the exploration of paradoxes [40], seeking alternatives and leveraging past experiences in new contexts [41]. In the Circular Value toolkit, our approach to breaking companies and their ecosystems out of their conventional, linear thinking patterns is to redefine the roles of key actors in the SCE. Haase et al. [9] have developed a new theoretical framework in which actors acquire new names and roles to establish new practices and behaviours that favour value preservation. For example, consumers are not merely consuming products, but become value-cooperators, who cooperate with the companies to preserve the value of the products during the time of ownership via maintenance and repair. This redefinition of roles is outlined in Table 2.

Table 1 Factors with a negative impact on product value perceived by consumers in the five use-stages, identified by Haase et al. (2024). Reduced version. Own illustration

Factors with a negative impact on product value perceived by consumers in specific use-stages				
Pre-acquisition	*Early-use*	*Middle-use*	*Late-use*	*Pre-disposal*
Functional value	Economic Value	Economic Value	Economic Value	Economic Value
- Unclarified needs	- Purchase regret due to missed better alternatives	- Deals, trade-in programs, and subscription models	- The cost of repairing is high compared to the price of new products	The monetary upcycling cost is high compared to purchasing a new product
- Obsolescence strategies resulting in lower product lifetime expectations	- Switching cost to an alternative, new product is low	- Perceived obsolescence due to new technology, features, models etc	- Short-term product warranties	
Emotional/Epistemic value	Functional value	Functional value	Functional value	Functional value
- Low purchase price resulting low performance expectations	- Mismatch between product function and needs	- Lost the original performance	- Usability is decreased due to repair	- Predicted usability of upcycled products are low
- Low expectation of quality lowers products mental book value	- Lower product performance than expected	- Lack of time/skills to perform regular maintenance	- The product does not allow repair	
	- Lack of product knowledge on lifetime, correct use or maintenance			
Social or Sign value	Emotional/Epistemic value	Emotional/Epistemic value	Emotional/Epistemic value	Emotional/Epistemic value
- Inferior appearance compared to similar products	- "Faultless forms and surfaces" that seem too pretty to be used	- Association undesired memories or identity	- Lack of skills or positive repair experience	The behavioural upcycling cost is high (e.g., time, effort, upcycling skills)
- Display social images, wealth or social status		- Low use frequency	- Replacement services are more convenient than repair services	
	Social Value	Social or Sign value	Social or Sign value	
	- Rapidly vanished meanings (e.g., fashion image)	- Damaged, dirty or old appearance	- Association between repairing and economic hardship/poverty	

Systemic Innovation and Ecosystem Thinking

The third theoretical building block for the Circular Value toolkit is systemic innovation and ecosystem thinking. Solutions developed for value preservation are often systemic innovations that require a networked approach to explore complementary innovations and business models. Establishing a shared understanding of the problem or opportunity and ensuring alignment between partners' interests is therefore necessary [42, 43] and crucial for creating internal agreement and ensuring support [44]. Achieving this requires partners to share their interests and ideas and exchange knowledge to align their understanding of key terms [45]. All are elements that the toolkit should support.

Methodology

The study employs a Design Science Research (DSR) approach, which has been extensively applied in circular design and business model innovation [32–34]. DSR generates scientific knowledge through inquiry into innovation efforts, frameworks, and tools by developing and evaluating these through rigorous empirical work [46]. In developing the Circular Value toolkit, we pay close attention to research in CE, emphasising common challenges when developing tools and frameworks for practical use, such as balancing available tools and the needs of practitioners and addressing real-world practical problems [47, 48]. The DSR approach [46] was selected to account for these shortcomings. To further ensure a practitioner-centred development, we follow the revised tool checklist created by [27].

The DSR design and evaluation process incorporates an iterative evaluation and redesign of the tool/artefact to increase usability, quality and efficacy [49, 50].

The use of DSR to develop the Circular Value toolkit can be found in Fig. 1.

Demonstration

The demonstration and further development of the toolkit occurred in three distinct phases.

Phase one involved an expert group of academic researchers, who co-authored this paper, to form the theoretical structure of the toolkit. The expert group was identified as appropriate, as they represent a range of disciplines within the circular economy, including business, design, environmental sciences and sociology.

In phase two, 15 small and medium-sized companies from diverse sectors applied and evaluated the Circular Value toolkit. The companies came from the building, furniture, textile, and machinery industries and ranged from product manufacturers to service-system providers. In the demonstration, participants were grouped into five teams of 4–5 persons according to industries and interests.

Phase three included 24 PhD students from across Europe, working with CE, to apply and evaluate the toolkit. The PhD students were identified as relevant for the demonstration because many of the PhD candidates were enrolled in industrial PhDs or worked closely with industry cases, which provided them with the relevant product and business knowledge to evaluate the toolkit.

The two practical demonstrations of The Circular Value toolkit (iterations 2 and 3) applied the following format.

Table 2 Examples of new roles, practices, and behaviours required of key actors to ensure efficient value preservation in a SCE based on Haase et al. (2024). This list is not complete. Own Illustration

Value transformers	Value co-operators'	Value gatekeepers'	Value accountants
(former product developers)	(former consumers)	(former businesses)	(former authorities)
New role: Value transformers must cater for consumers' changing needs over a longer period and design products that can be changed or transformed during their lifetime for multiple renewals	New Role: Value Co-operators must ensure maximum utility of products and value preservation through multiple use loops. This includes resisting impulse purchase, prioritize durability and commit to maintaining, upgrade, repairing and reselling products,	New Role: Value Gatekeepers must provide circular options to the consumers and thus ensure that products and materials are kept in use for as long as possible and are marketed in a way that enables this. This includes, avoidance of obsolescence strategies, provide take-back system, standardized spare parts etc	New Role: Value Accountants must ensure that new regulations and governance initiatives enhance value preservation and thus set a direction for a sufficiency approach to production and use. This includes Promoting a legal system for spare parts access and reasonable pricing, encourage repair

1) Introduction: to the Circular Value toolkit, CE principles and strategies, and Value Preservation Theory (in plenum).
2) Group assignment: application of the Circular Value toolkit to an industry/company product.
3) Presented the outcome of the work with the toolkit, facilitated by 3 A1 posters. (The PhD students supplemented their presentations with 5 PowerPoint slides)
4) Evaluated the toolkit (individually on evaluation forms and in plenum).

The practice demonstrations were facilitated by two of the authors, while in iteration 2, the remaining four authors supported the teams during the group assignments. For each of the three iterations, further improvements to the Circular Value toolkit were created.

Evaluation and Data Collection

For the evaluation of the toolkit/artefact, Peffers et al. [51] have identified a range of quantitative and qualitative evaluation methods. For the Circular Value toolkit, we apply ethnographic observation of use [52, 53] evaluation forms [54] and discussions. Data was collected by both the facilitators and workshop observants, capturing notes from the demonstrations, toolkit material (i.e., participants' notes written on or attached to the three maps – see Figs. 2, 3 and 4), notes from the oral presentations, as well as the physical evaluation form completed by each participant (detailed later in the paper). Additionally, the researchers who facilitated the demonstration workshops reflected upon facilitation improvements based on observations and field notes.

The Circular Value toolkit was evaluated both by the researchers involved and by the participants. The goal of the researcher-evaluation was to examine whether the toolkit provides practical support in 1) identifying points in the product lifetime where value is currently decreased or destroyed, 2) developing ideas and concepts to prevent value destruction, and 3) identifying barriers and opportunities for initiating collaboration with ecosystem stakeholders. This evaluation was created based on the oral presentations and material produced by participants, as well as the researchers' observations and notes from the workshops. The participant evaluation focused on evaluating the toolkit's usefulness and understandability on a scale from 1–5, where one was "not very", and five was "very much", as outlined by [54].

Data Analysis

To analyse the qualitative material generated through the demonstration workshops, we applied an iterative coding and thematic analysis process. This approach enabled a systematic interpretation of the diverse data sources collected, including observation notes, participant annotations on the toolkit maps, material from the oral presentations, and written evaluation forms. The analysis followed established qualitative procedures for inductive coding and theme development within grounded theory, allowing insights to emerge directly from the empirical material rather than from predefined categories [55, 56].

The coding process began with an initial open-coding phase in which all data were reviewed. During this stage, meaningful units of information related to participants' interactions with the toolkit, their interpretations of the maps, and their reflections were identified.

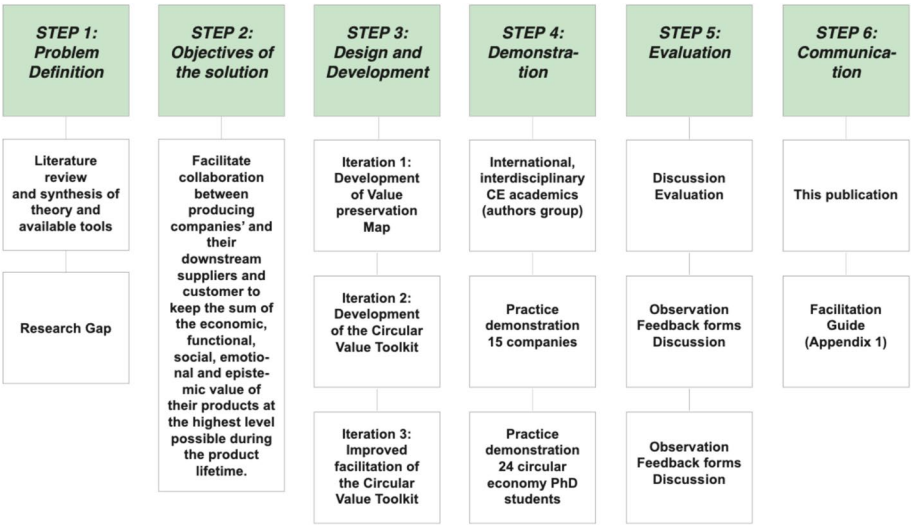

Fig. 1 Development of the circular value toolkit based on the design science research (DSR) iterative approach (inspired by Hevner [49]; Peffers et al. [46]; Romme and Reymen [50]). Own illustration

Attention was paid to instances that corresponded directly to the toolkit's intended outcomes, including identification of value destruction, proposed strategies to prevent this, or articulated barriers and enablers for initiating ecosystem collaboration.

Following open coding, several broader conceptual themes were developed and discussed among the researchers, who participated in the demonstration. These discussions, along with opportunities to cross-check data from multiple sources, strengthened the validity of the evaluation and offered nuanced insights into how the toolkit functions in practice [57, 58].

Results

The Circular Value toolkit

Circular Value toolkit is a three-step process with three accompanying maps: The Value preservation map, The Pattern breaking ideation Map and the Value Eco-system Map (see Figs. 2, 3 and 4). The Circular Value toolkit is intended for use at the strategic level of the company, including business, product development and CSR. We present our results following Gregor & Hevner's [59] recommendations of first describing the designed toolkit (one map at a time), including practical guidance on how to apply the toolkit, followed by a description of the iterative development process, including the evaluation of the toolkit's usefulness and changes made based on the evaluation.

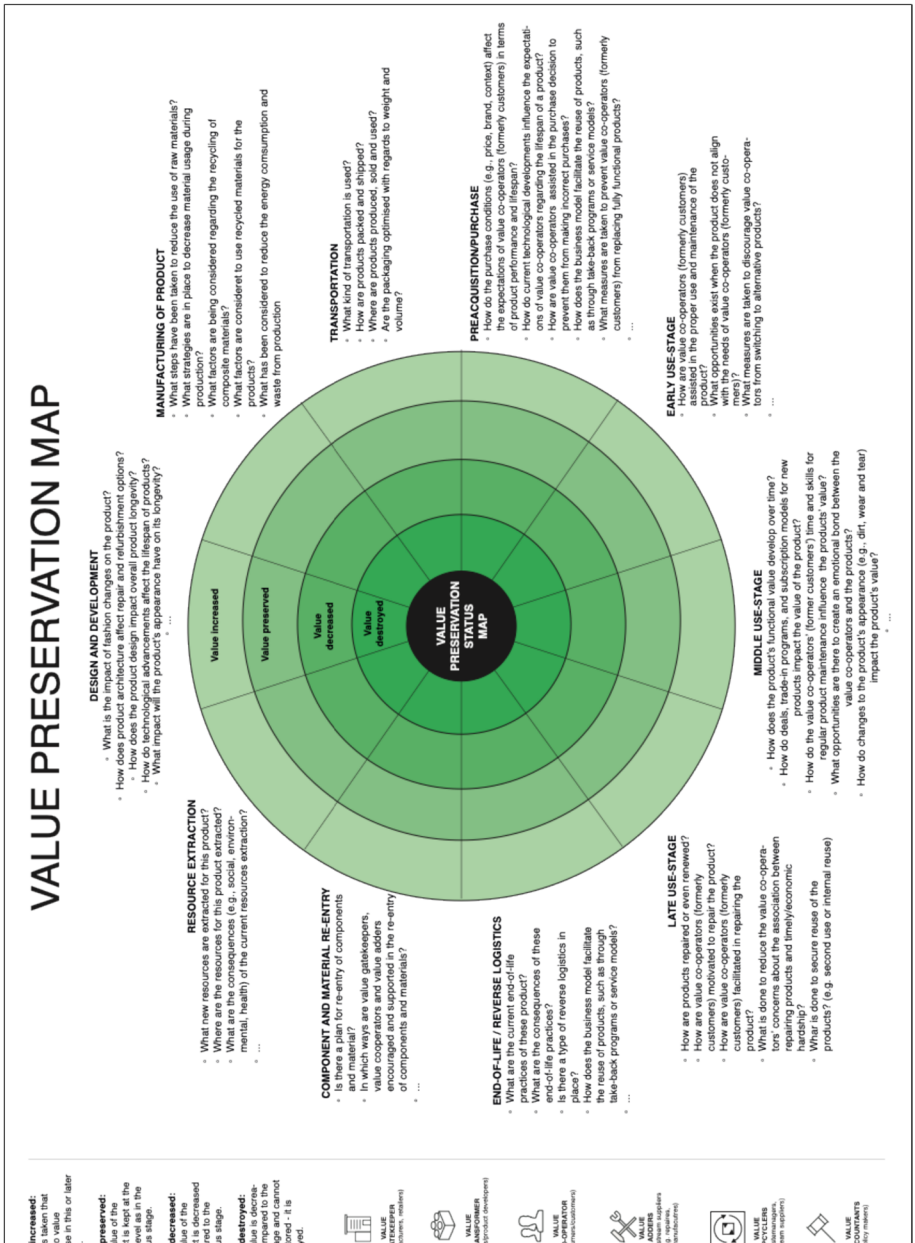

Fig. 2 Value preservation map (Own illustration)

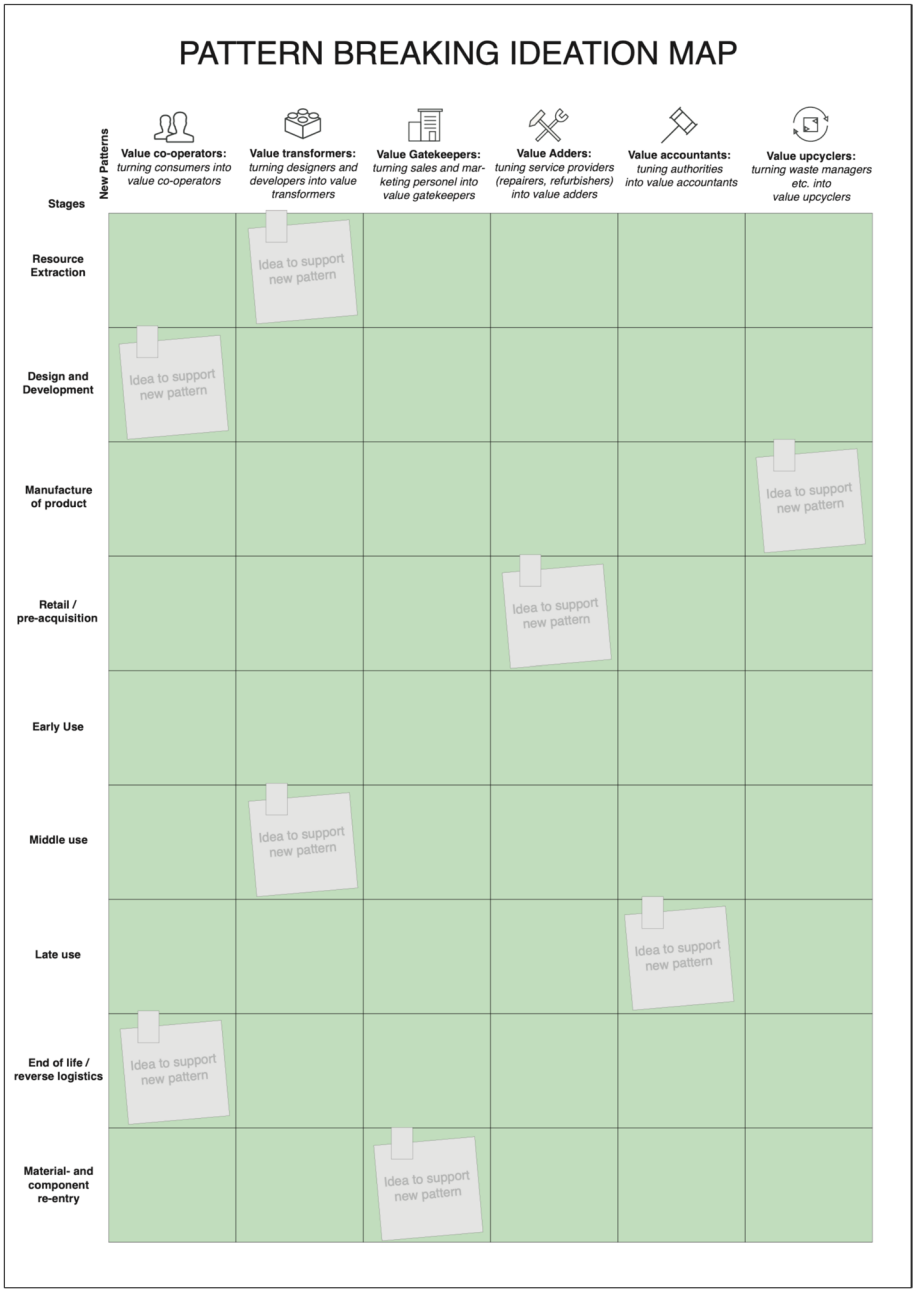

Fig. 3 Pattern breaking ideation map (Own illustration)

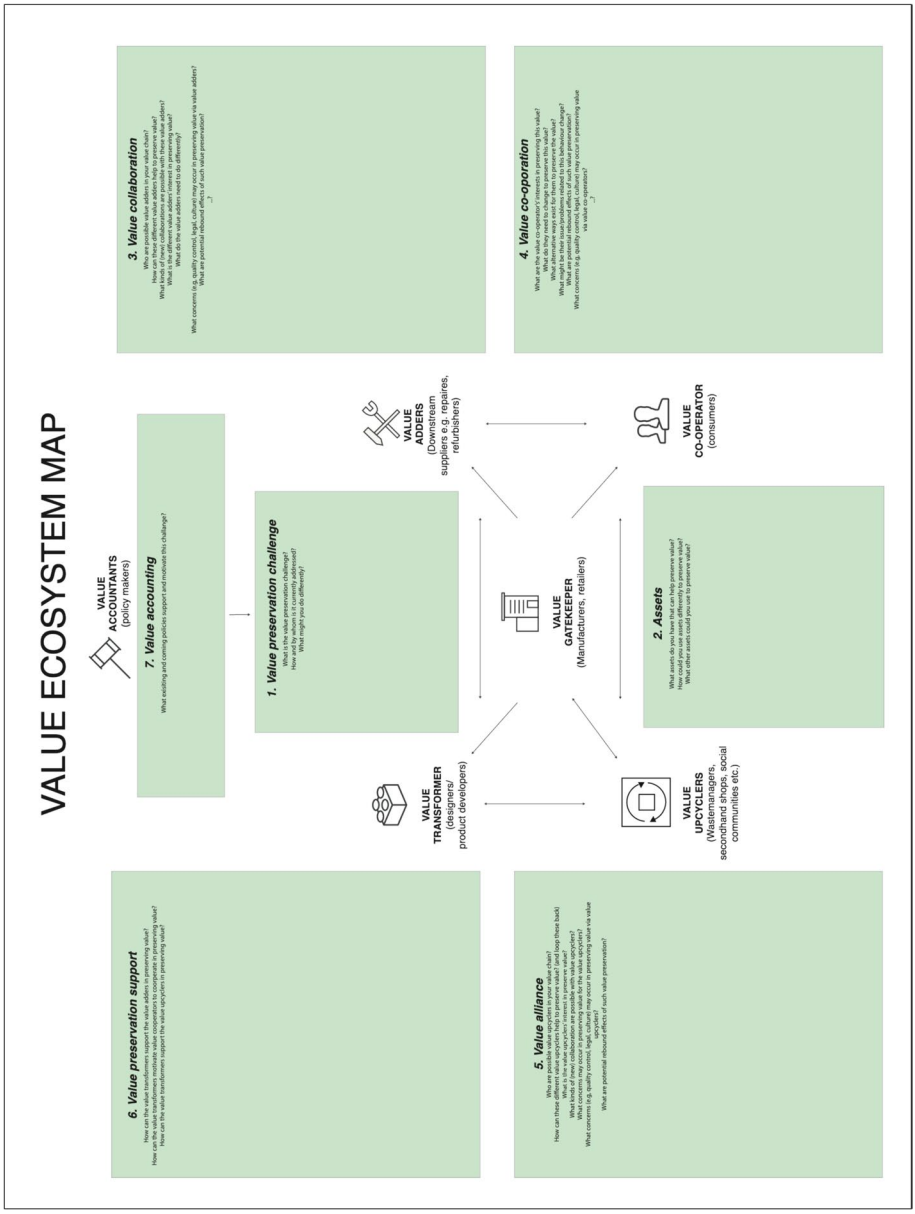

Fig. 4 Value Ecosystems Map (Own illustration)

The Value Preservation Map

The Value Preservation Map aims to support companies and organisations in identifying where the product's value is increased, preserved, decreased or destroyed throughout the product's lifetime. To provide this overview, the map combines Mestre & Cooper's [60] model of circular development with [61] the model of circular consumption, resulting in

10 distinct product lifetime stages (see Fig. 2) At each stage of the product's lifetime, there are several questions to facilitate reflection and discussion among the toolkit users. These questions are based on previous research. During stages 1 to 4, we integrate knowledge from circular design and product longevity (e.g. [47]). In stages 5 to 9, we integrate knowledge on factors that negatively impact the value perceived by consumers (see "Value Preservation and Product Lifetime" section). Finally, in stage 10, we integrate knowledge on material preservation (e.g. [62]).

The areas where the toolkit users identify critical value decrease/destruction become the focus in the second step of the toolkit.

Pattern Breaking Ideation Map

The aim of the Pattern Breaking Ideation Map (see Fig. 3) is to support companies in developing ideas and concepts to prevent value decrease or destruction, as identified in the Value Preservation Map. We introduce a matrix for developing ideas and concepts to preserve value at any stage of the product's lifetime. This idea generation matrix also incorporates the new roles suggested by Haase et. al. [9]. Moreover, we choose to add two new roles: The value adder (formerly downstream suppliers, such as repairer and remanufacturer) and the value upcycler (formerly waste managers or upstream suppliers) to include all relevant eco-system actors. An overview of the new roles can be found in Table 3.

The Pattern Breaking Ideation Map facilitates the exploration of numerous potential solutions and ideas and allows for a comprehensive evaluation and selection of the most promising idea for further development. The Map was based on elements that had previously been evaluated in two other company settings in the CircularTex project (https://trace.dk/textiles/circulartex/).

Value Eco-system Map

The Value Eco-System Map aims to help companies identify suitable downstream suppliers, customers, and other ecosystem stakeholders essential for the successful implementation of new value preservation ideas or solutions. The Value Ecosystems Map, shown in Fig. 4, provides companies with an overview of stakeholders crucial for long-term value preservation, their roles and motivations, and potential conflicts of interest or rebound effects of the new solution or idea. The Value Ecosystem Map includes several facilitating questions related to each stakeholder, inspired by the *Circular Pitch and Action Template* developed by Brown et al. (2021) and the *Circular Rebound Tool* developed by Das et al. (2023).

Practical Guidance on How to Apply the Circular Value Toolkit

Value Preservation Map Guide

The first step for companies, whether working individually or collaboratively, is to apply the Value Preservation Map. For companies with diverse product categories, it is advisable to create a separate map for each product. At each lifetime stage, our participants reviewed questions related to the product or product categories and evaluated whether the product's value was increased, preserved, decreased, or destroyed. The value of the product is the sum

Table 3 Overview of the new roles in the Circular Value toolkit to ensure efficient value preservation—based on Haase et al. (2024). Own Illustration

Value transformers	Value co-operators'	Value gatekeepers'	Value accountants	Value Adders	Value Upcycler
(former product developers)	(former consumers)	(former businesses)	(former authorities)	(former repairer and remanufacturer)	(former waste managers etc.)
Value transformers must cater for consumers' changing needs over a longer period and design products that can be changed or transformed during their lifetime for multiple renewals	Value Co-operators must ensure maximum utility of products and value preservation through multiple use loops	Value Gatekeepers must provide circular options to the consumers and thus ensure that products and materials are kept in use for as long as possible and are marketed in a way that enables this	Value Accountants must ensure that new regulations and governance initiatives enhance value preservation and thus set a direction for a sufficiency approach to production and use	Value Adders must ensure that repair and remanufacturing services are available and as easy to access as purchasing new products	Value Upcyclers must ensure that products and materials are used and reused, until the full potential of the products are achieved, before contributing with upcycling services

of its economic, functional, social, emotional, and epistemic value. The primary rule in the evaluation is that any decrease or destruction of a specific value outweighs an increase or preservation of another. For instance, if the economic value of a product decreases during the early use stage, but its functional value is preserved, the total sum of the product's value is still considered to have decreased.

By going through each of the 10 stages, participants formed an overview of the value changes throughout the product lifetime, as indicated by the *blue line* in Fig. 5.

Pattern Breaking Ideation Map Guide

The second step for companies is to apply the Pattern Breaking Ideation Map, as reviewed in Fig. 6. It supports the ideation phase by addressing the weaknesses and opportunities identified in the Value Preservation Map. The matrix within the Pattern Breaking Ideation Map can be utilised in various ways. For instance, a team may choose to concentrate on a specific lifetime stage (e.g., the design and development stage). Alternatively, the team can choose to work on multiple or all stages concurrently. We recommend facilitating the ideation process as follows: begin with 10 min of individual ideation, followed by presentations to the other participants. During the presentations, participants are encouraged to build on each other's ideas. Toolkit users are encouraged to develop ideas where the products' value decreases the most, but also to generate ideas elsewhere to gain a comprehensive understanding of what full value preservation means for their product in practice. A key rule is to keep ideation and evaluation separate; therefore, participants should refrain from critiquing each other's ideas until the end of the session. At that point, all participants are asked to identify the idea or ideas they wish to advance to the Value Ecosystem Map.

Value Eco-system Map

Value Ecosystems Map, shown in Fig. 7, assists companies in realising pattern-breaking ideas by performing stakeholder mapping to consider how these new ideas can be implemented. Utilising this map, practitioners are encouraged to consider: What new roles are required for the different actors across the value chain? What is their interest in preserving value? What new collaborations are possible in the value chain? What are the potential concerns for preserving value? And what are the potential rebound effects?

The Value Ecosystem Map consists of seven sections (numbered in the map), beginning at the centre with the *Value Preservation Challenge*, where the idea is described in terms of a value preservation challenge.

Iterative Development and Evaluation of the Circular Value Toolkit

The following three sections provide detailed accounts of the changes the Circular Value toolkit underwent during its three iterations, with the corresponding rationale as well as insights based on data gathered from the two demonstration workshops.

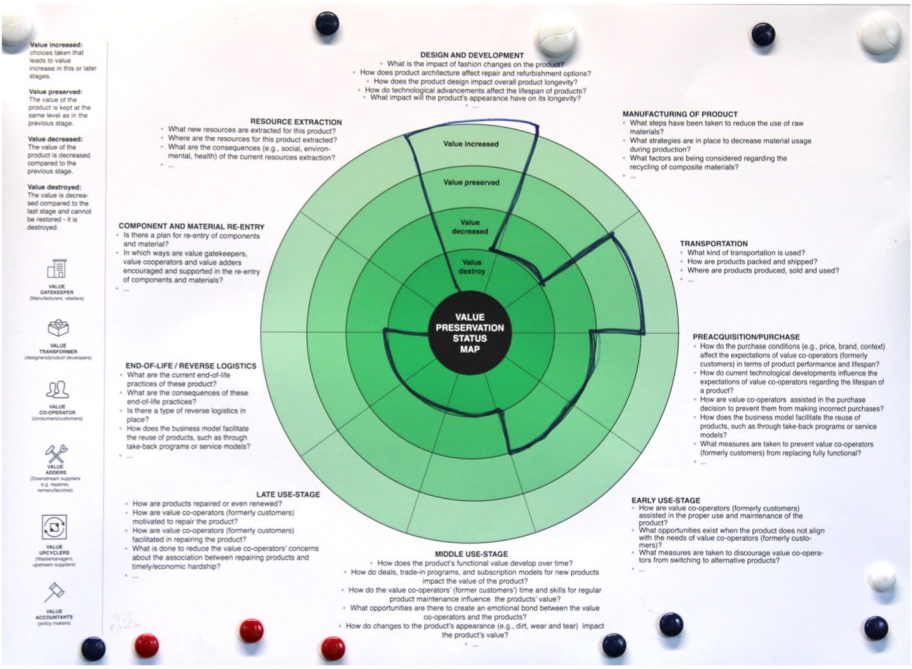

Fig. 5 Value preservation map filled out to demonstrate the outcome

Fig. 6 Company demonstration: work with the pattern-breaking ideation map

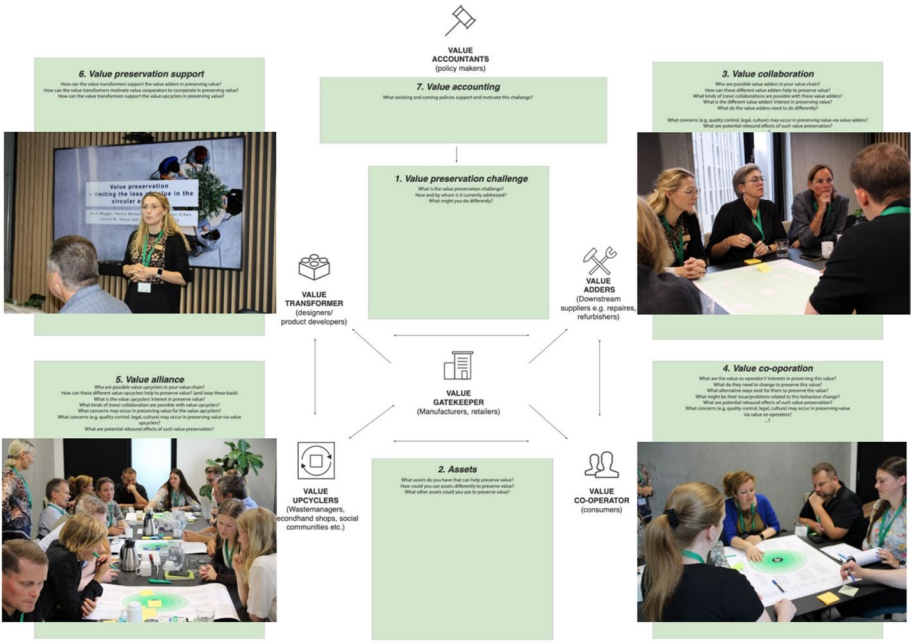

Fig. 7 Value Ecosystems Map and pictures from the demonstrations

Phase One – Forming the Theoretical Structure

Phase one primarily focused on value preservation. The main idea was to use the Value Preservation Theory, as outlined by Haase et al. (2024), as the foundational theory for the new toolkit (Walls et al., 1992). However, the outcome—a first version of what later became the Value Preservation Map—did not fully achieve the research objectives. While it provided a mapping and overview of value increase, preservation, decrease and destruction, it did not create the necessary means to engage companies, customers, and downstream suppliers in preserving or reproducing the value of the products. In the second iteration, we therefore developed two new maps. The three maps combined provided the companies with an overview of the present status, new ideas and concepts for value preservation, and identification of barriers and opportunities for initiating collaboration with ecosystem stakeholders.

Phase Two – Company Demonstration and Evaluation

The second demonstration and evaluation of the Circular Value toolkit took place during an in-person workshop.

We observed that the Circular Value toolkit supported the companies in 1) identifying the points in the product lifetime where value is currently decreased or destroyed, 2) developing ideas and concepts to prevent value destruction, and 3) identifying barriers and opportunities for initiating collaboration with ecosystem stakeholders. Moreover, the companies were supported in articulating the "strategic choices to be made by the management. For companies producing durable and long-lasting products, the Circular Value toolkit helped enhance

the value proposition towards the customers by highlighting areas where the product's lifespan might be compromised, even if it was intended differently. An example of this from the demonstration involved a window company. Here, the toolkit users identified extreme value destruction in the middle and late use stages. This was primarily due to customers being unaware of the possibility of exchanging the glass (e.g., to energy optimize the house) rather than replacing both the frame and the glass. To overcome this issue, the development of a service network with repairers was suggested.

For companies manufacturing products with shorter lifespans, the Circular Value toolkit helped evaluate the current situation and identify the most impactful initiatives for improvement. An example of this from the demonstration involved a city surveillance company that manufactured lampposts with cameras. The toolkit users identified large value destruction in the middle-use stage due to the high risk of malfunctioning electronics. To address this issue, they developed a modular design accompanied by a related service setup.

Additionally, we observed that a high level of facilitation and guidance was required, particularly regarding how to weigh different types of value and the new roles. Therefore, in the next iteration, participants were asked to read the paper by Haase et al. [9] before the workshop. Further, we found that the time needed to complete the different maps varied substantially. Consequently, in the next iteration, the introduction to the maps was provided at the beginning of the workshop, allowing participant groups the freedom to organise their time as needed.

In the participant evaluation, the company participants rated the toolkit on average usefulness of 3.9 out of 5, and an ease of understanding 3.5 out of 5. The evaluation also pointed to the Circular Value toolkit as being both interesting and eye-opening: *"Great tool to think differently"* and *"Opened my eyes to what is possible and [created] great discussions around the table"*. Participants also found the toolkit helpful: "The circular economy is increasingly becoming a topic of interest in various industries. [The toolkit] helps our work and approach to implementing it". Additionally, the structure of the material (i.e., the maps) was appreciated*:" The workshop material [the printed maps] was very interesting, embracing the issue".*

Phase three – PhD Student Demonstration and Evaluation

The third demonstration and evaluation of the Circular Value toolkit took place during an in-person workshop with multiple PhD students specialising in CE.

We observed that the PhD students found it easier to apply the different maps and understand the assignments. Consequently, the instructors were more frequently consulted regarding the content of the different assignments rather than on the use of the maps.

It was suggested to use the Value Preservation Map more efficiently and to avoid the team getting caught up in discussions. Hence, the definition of value as the sum of its economic, functional, social, emotional, and epistemic value needed to be exemplified. A few changes to the formulations of the questions in the Value Ecosystem Map were suggested. This change was included and implemented in the final version of the Circular Value toolkit. On average, PhD students evaluated both usefulness and ease of understanding to 3.5 out of 5. Those PhD students with the closest contacts to industry were more enthusiastic about the tool in general and highlighted the usefulness of the tool in the oral discussion.

Discussion

This paper developed, investigated, and qualified the Circular Value toolkit, which companies can use to initiate collaboration with customers and downstream suppliers, ensuring the efficient preservation of products' value(s). The Circular Value toolkit bridges this gap in circular design, business and innovation research. Prior research emphasises that while tools have been developed to support companies in circular business model innovation, few focus on the value chain or the ecosystem, and none support companies in shifting focus from reducing materials and recycling towards value preservation and an SCE.

The demonstration of the Circular Value toolkit substantiates findings from previous studies, which highlight that visualization tools offer an effective way to think and work collaboratively [63–65]. Moreover, the trigger questions on the maps encouraged the toolkit users to think deeply about the unintended effects of their own actions, the different stakeholders' interests and their role in the ecosystem going forward. This also aligns well with previous research that points to the trigger question's ability to stimulate a change in current perspectives [66, 67].

Likewise, the integration of both analytical (the Value Preservation Map) and conceptual (the Pattern Breaking Ideation Map) and the actional elements (the Value Eco-system Map) in the Circular Value Toolkit was highly appreciated by the company practitioners. This aligns with current research on circular tools and shows that it is of vital importance to connect analytical insights with actionable plans for any tool to be successful in practice [47]

Finally, even though the teams working with the Circular Value toolkit came from different backgrounds and even different companies, it was clear that through the process, they had been able to create a shared understanding of both challenges and possible solutions. This supports previous research findings on the importance of shared language (in this case: value and value preservation terminology) and shared understanding in innovation processes [25, 68]

Limitations and Future Research

This study presents an explorative investigation into toolkit development, and as such, it holds some limitations. First, the evaluation of the Circular Value toolkit was limited to a short-term demonstration. Hence, the long-term impacts and strategic importance of the toolkit in a company setting are beyond the scope of this study. Secondly, we expect the effectiveness of the Circular Value toolkit can be highly improved in practice by combining it with a tools for redesigning to sufficiency-based circular business models (e.g. [33, 35]). Thirdly, the toolkit was evaluated only by small and medium-sized companies, where the knowledge regarding the product and product portfolios is typically concentrated within a smaller group of people. We assume some adjustments are needed to make the Circular Value toolkit work optimally in large scale cooperations, where responsibilities are more distributed and decision-making structures more complex.

The abovementioned limitations highlight the need for future research to move beyond short-term workshops and controlled demonstrations. While the present study provides initial insights into the toolkit's usability and perceived value, it does not capture how the toolkit performs when embedded in real organizational routines, subjected to competing priorities, or used by diverse stakeholder groups over time. To address this gap, future work

should include longitudinal studies in which companies apply the toolkit throughout multiple product development cycles. Such research would enable the assessment of long-term behavioural changes, integration into existing processes, and the extent to which the toolkit influences strategic decision-making.

The toolkit itself also has some shortcomings. First, it lacks quantitative measures to support the selection of the most relevant areas of value decrease or destruction to explore (Value Preservation Map), as well as proper evaluation of the idea solutions (Pattern Breaking Ideation Map). This issue could be addressed by applying Life Cycle Analysis principles or low-fidelity tools, similar to those used in the building industry (see e.g. [69, 70]). Another opportunity could be to use technologies such as digital twins, which monitor material flows, optimise life cycle or circular procurement processes, to qualify or prioritise the solutions. Secondly, the practical feasibility of the designed solutions and their corresponding business models for the engaged actors in the ecosystem needs to be further explored. This could be addressed in the continued development of the toolkit or considered as part of its facilitation.

Future research on the Circular Value toolkit should include longitudinal studies following companies that have utilised the toolkit to develop new ideas and solutions for value preservation, as well as tracking the initiation of collaboration with other actors in the downstream supply chain. This requires longitudinal studies in which companies apply the toolkit over extended periods, allowing researchers to observe how it influences decision-making processes, product development practices, and strategic sustainability initiatives. By combining repeated observations, follow-up interviews, and in-depth case studies, future work can provide a more comprehensive understanding of the toolkit's practical value and its potential to drive value preservation at scale.

Another possibility is focusing on the application of the toolkit across various company sizes, particularly large-scale corporations or adoptions for other main target users. While the Circular Value Toolkit was originally intended for use at the strategic level of the company, including business, product development and CSR, we see easy adoption possibilities for other stakeholders. In particular, the demonstration with PhD students showed that the toolkit could be adopted by other stakeholders in the downstream supply chain, such as the value co-operators (e.g., citizen or consumer groups), value adders (e.g., service or repair providers), and even value accountants (legal authorities).

Finally, further development of the toolkit in terms of qualifying the resulting solutions generated from utilising the toolkit could be relevant to explore.

Conclusion

This study contributes to the existing literature on toolkits (e.g., [27]) with a practitioner-oriented and empirically evaluated Circular Value toolkit for value preservation. Value preservation requires a shift in the roles and business activities of various actors and close collaboration to identify where value decreases or is destroyed throughout a product's lifetime. Developing actionable plans to preserve or increase the product value is essential, and the Circular Value toolkit addresses these issues.

The demonstration and evaluation presented in this paper indicate that the Circular Value toolkit supports companies in:

1) identifying the points in the product's lifetime where value is currently increased, preserved, decreased or destroyed.
2) developing ideas and concepts to prevent value decrease or destruction.
3) Identifying barriers and opportunities for initiating collaboration with ecosystem stakeholders to ensure the efficient preservation of product value throughout the product's lifetime.

Moreover, the Circular Value toolkit provides companies with an integrative view of value and supports reflections on how their actions and strategies influence the other actors in the ecosystem.

For companies producing durable and long-lasting products, the Circular Value toolkit can help enhance the value proposition towards the customers by highlighting areas where the product's lifespan might be compromised, even if it was intended differently.

For companies manufacturing products with shorter lifespans, the Circular Value toolkit can help evaluate the current situation and identify the most impactful initiatives for improvement.

From a managerial perspective, the Circular Value Toolkit aligns different perspectives and understanding of what is needed to achieve a sufficiency-based circular economy, by constantly nudging the participants to reflect upon whether value is preserved.

This study also contributes to circular business and innovation theory with a new integrative view on value and value preservation. It introduces Value Preservation as a key methodological approach to develop solutions aligned with the concept of sufficiency-based circular economy (SCE). Thereby, the paper addresses some of the roadblocks that currently hinder companies' transition from a linear economy to a sufficiency-based circular economy (SCE).

As reviewed in the introduction, there is, in general, a tendency in the industry to adopt the least impactful circular strategies, such as material reduction and recycling, rather than strategies that will slow resource loops. Value preservation places emphasis on and prioritisation of the strategies for slowing resource loops. Hence, the integrative view on value and value preservation holds significant possibilities for future research within the sufficiency-based circular economy.

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Declarations

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