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Dynamics of Business Models in Circular Economy: Shifting Challenges in Pilot Projects

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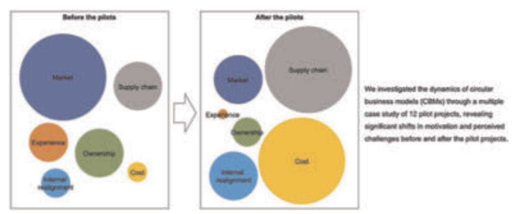
SIGNIFICANCE

In this publication, the progressing perspectives of consortia from before to after piloting circular business models (CBMs) are described. We observed significant changes in motivation, perceived challenges and potential ascribed to the piloted CBMs. We demonstrate that understanding the dynamics of organizational learning, the timing of economic considerations, and the complexities of PSS implementation is most important for practitioners and researchers who aim at effective and sustainable circular business practices.



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ABSTRACT

This study investigates the dynamics of circular business models (CBMs) through a multiple case study of 12 pilot projects funded by the German Federal Ministry of Education and Research between 2019 and 2022. The aim of this study was to draw practical conclusions for CBM pilot projects and public funding tenders, as well as to reveal theoretical insights into the motivation, perceptions of challenges, and potentials regarding CBMs and their shifts over time. Focused on remanufacturing and product-service systems (PSS), the study reveals significant shifts in motivation and perceived challenges before and after the pilot projects. Post-pilot, financial considerations emerged as a primary motivator for CBM adoption, alongside market pull factors and resource availability. However, challenges such as cost-related issues, supply chain complexities, and internal realignment hurdles persisted. Conversely, the perception of market-related challenges had decreased after the pilots, suggesting a growing readiness and adaptability of the market to CBMs. Similarly, experience-related challenges saw a decline, indicating an improvement in knowledge and capabilities within consortia over time. Moreover, the study examines shifts in perceived potential, revealing heterogeneous outcomes across different types of CBMs. While some projects identified new possibilities for value chain cooperation and transparency, others expressed skepticism about further potential, particularly in PSS-focused pilots. This study contributes to the growing body of literature on CBMs by providing empirical insights into the dynamics of circular economy (CE) pilot projects and their impact on organizational learning.

Introduction

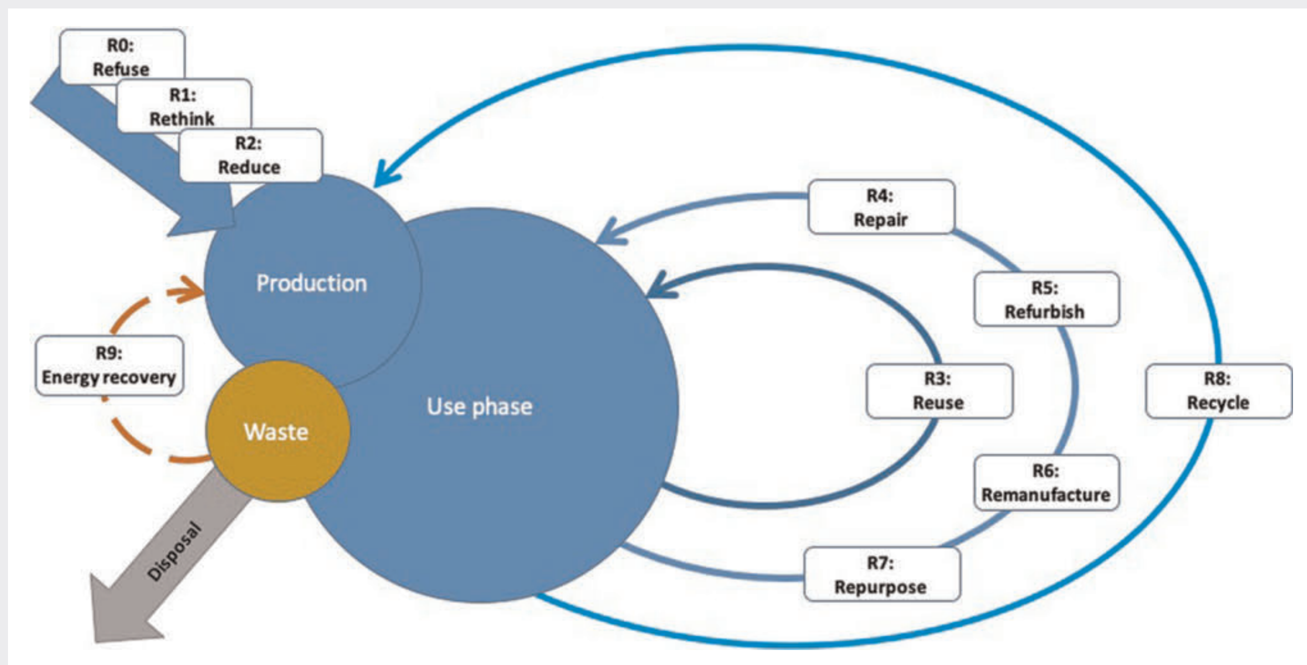
Our current resource use is unsustainable. Several planetary boundaries have already been crossed [31] and resource scarcity is increasingly being felt across the global economy. Prolonged and repeated use of products and materials in a circular economy (CE) can ensure better resource stewardship by reducing the demand for primary resources extracted from the planet [32]. On an organizational level, business models in a CE or circular business models (CBMs) organize business activities toward more sustainable resource use by narrowing, slowing, and closing resource loops [4]. However, CBMs face various challenges due to their complexity and, in many cases, their early stage of development [5, 8, 17].

Experiments are needed to deal with the uncertainty inherent in a new and complex area such as sustainability-oriented innovation [40]. While experiments tend to focus more on minimum viable products that test individual assumptions, pilots encompass more aspects of the business model and include interactions with real customers [5]. Such pilots contribute to organizational learning which can build the basis for larger strategic roadmaps, whether on a political level or by individual companies. This can be enriched by analyzing the so-far-underexplored changes in motivations and perceptions during the piloting phases. Previous studies also highlight the need for monitoring innovation processes over longer periods [5] and better understanding of organizational learning in a CE context [37].

This article addresses these gaps by gathering insights from a funding measure of the German Federal Ministry of Education and Research ("ReziProK") that focused on new technical solutions in combination with CBMs. Twenty-five projects were started in May 2019 and completed between mid-2022 and the end of 2022. Of these projects, 12 were analyzed in more depth. Only business models that go beyond new recycling processes and for which detailed information could be provided by the project managers were considered. Each of the 12 pilots was conducted by a consortium of companies and research institutes and, thus, represents the dynamic value chains needed for CBMs in which assets and value are shared with partners [20]. The pilots focus on remanufacturing and product-service systems (PSS), both of which tend to be more common in the manufacturing and business-to-business (B2B) context [30]. Such business models are characterized by take-back schemes due to their emphasis on extended producer responsibility and logistics [33]. This study's objective is to compare and evaluate the results of these 12 pilot projects via a multiple case study examining the challenges faced by the project teams as well as how their outlook had changed once the pilots were concluded. In doing so, we contribute to the literature on piloting for CBMs toward a CE by shining light on learning processes and their results with a view toward the potential implementation in the market and the considerations to be made at the start of such pilot projects.

Background

The EU Taxonomy defines the CE as "an economic system whereby the value of products, materials and other resources in the economy is maintained for as long as possible, enhancing their efficient use in production and consumption, thereby reducing the environmental impact of their use, minimising waste and the release of hazardous substances at all stages of their life cycle, including through the application of the waste hierarchy" [13]. The explicit reference to the waste hierarchy implies, among other aspects, that reuse should be prioritized over recycling and that waste should be used as raw materials through recycling. Beyond the potential for increased environmental protection, the expected economic benefits of the CE include better access to raw materials, increased competitiveness, and new job opportunities [12]. To leverage these benefits, companies need to create CBMs in which resources are used more efficiently (narrowing resource loops), for longer periods of time (slowing resource loops), and through repeated use phases (closing resource loops) by applying one or more circularity strategies [4]. The common "9R-framework," which summarizes CE strategies, each starting with the letter "R," [9, 24, 29] was previously used to classify the pilot projects [15] and will, therefore, be applied in this article as well (▶ **Fig. 1**). With a focus on technical loops, these strategies (R0 to R9) can be categorized according to their relation to the product or the function of the product, based on Potting et al [29]. The order of the strategies gives an initial impression of their effectiveness in line with the European Waste Framework Directive (WFD) [14], although the WFD is less differentiated. The earlier a strategy is applied in the value chain, the more effectively it can reduce or slow down resource consumption [26]. An overview of the strategies of the framework, including their interactions along the various phases of a



▶ **Figure 1** Overview and interaction of 9R-framework strategies. Modified, based on Potting et al [28].

simplified product life cycle, can be seen in ▶ **Fig. 1**. Strategies R0–R2 are upstream of the production process and include, for example, miniaturization, improving the durability of products, targeted use of secondary materials, and adapting the design to circular requirements. R0–R2 can be summarized as *upstream circularity facilitation*. The measures developed from this can support the realization of strategies R3–R7 in the context of product use, and R8 after the use phase. Thus, strategies R3–R7 focus on *use phase optimization*. R8 and R9 are waste-related strategies with the aim of reducing resource and energy requirements to support the manufacture of new products. These last two strategies revolve around *downstream waste valorization*, ideally following the concept of a recycling cascade where the preservation of resources at the highest possible structural level is prioritized to avoid downcycling [11].

CBMs face a distinctive set of challenges, including high upfront investments, financial uncertainty, the availability and cost of secondary materials as well as a lack of firm-level capabilities and challenges in organizing circular supply chains [16, 17, 36]. Unlike linear business models (LBMs), where success is often determined by the number of products sold, the validation of many CBMs hinges on the successful resale or repeated rental periods of products [21]. This distinction underscores the importance of extended examination periods for CBM pilots that allow enough time to build dynamic value chains and set up sufficient reverse logistics or take-back schemes. Such challenges assume a critical role during the use phase optimization (R3–R7) for PSS and remanufacturing-focused business models.

Remanufacturing refers to the use of parts from out-of-use products to make new products in which the part serves the same function as before [29]. This can require changes in design and logistical processes and, thus, can incur higher upfront costs than LBMs [21]. Reusing parts for remanufacturing tends to be more labor-intensive but requires less energy and primary resource consumption, thereby offering opportunities for job creation and environmental protection [10]. As part of its potential for improving the triple bottom line, remanufacturing can also lead to lower production costs and increased revenues [7, 18]. While remanufacturing has a strong connection to the production process, a PSS is mostly focused on the use phase and can be defined as “an integrated bundle of products and services which aims at creating customer utility and generating value” [6] (p. 252). PSS often requires close cooperation with other companies, leading to the need for complex cost- and revenue-sharing schemes as well as new delivery and supply channels [34]. PSS also entails higher risks for suppliers as they take care of not only production but also service provision over a long time [23]. This risk seems to increase with company size, suggesting that smaller companies benefit more from servitization [25]. The environmental benefits of PSS have been equally heralded as they have been called into question. While they offer the potential for intensifying the use of otherwise idle products, thereby reducing cost and resource consumption, the actual benefits strongly depend on the specific design of the PSS and its contingencies [34]. To support the proliferation of PSS, better insights into managing risks during the shift toward a PSS-centered firm are called for [34].

Despite advancements in CBMs, specific challenges, potentials, and unknowns persist within PSS and remanufacturing business models, necessitating further exploration. This study addresses this need by offering additional insights from industrial pilots and the changes in outlook that developed over the duration of the projects.

Method and Cases

The 12 pilot projects examined in this study were conducted between 2019 and 2022 as part of a research project funded by the German Federal Ministry of Education and Research as part of the FONA ("research for sustainability") program. All projects were carried out in co-operation between research institutes or universities and one or more industrial partners, such as manufacturers or users of individual products or product parts, software providers, etc. Documentation from before and after the pilots was compiled and analyzed, contrasting results from remanufacturing and PSS pilots as a multiple case study [41]. The classification into PSS and remanufacturing projects was based on their central activities; however, some consortia applied several CE strategies (see ▶**Table 1**). The 46 documents analyzed for this study include project surveys answered by the pilot project leads before and after the piloting phase, descriptions of the planned business models, as well as email exchanges with pilot project team members. During the data-gathering process, emphasis was placed on the motivation, challenges, and potential related to CBMs. These data were available from the pilots for all 12 projects, while comparisons of perspectives before and after the pilots were possible for 10 projects.

The pilot projects included five that were mainly focused on remanufacturing (Addre-Mo, CoT, EIBA, LEVmodular, and ReLife) and seven that revolved around PSS (CbD, DiTex, KOSEL, LifeCycling², PERMA, RessProKA, and wear2share). A case overview including a short description of each pilot is given in ▶**Table 1**.

The findings were then discussed with 10 CBM experts from different organizations in Germany to check for the validity of the results and to provide additional context for the discussion. The questionnaire for the experts is available as a supplement. An anonymized overview of the experts involved is included in ▶**Table 2**.

Results

The project leads were asked about their respective consortium's intention for exploring a CBM as well as the expected challenges and motivations before the projects started. The same topics were then explored after the projects concluded, examining the motivations ex-post as well as the perceived challenges and future potential of their CBMs. The main findings are explained below and will be discussed subsequently.

Shifts in Motivation

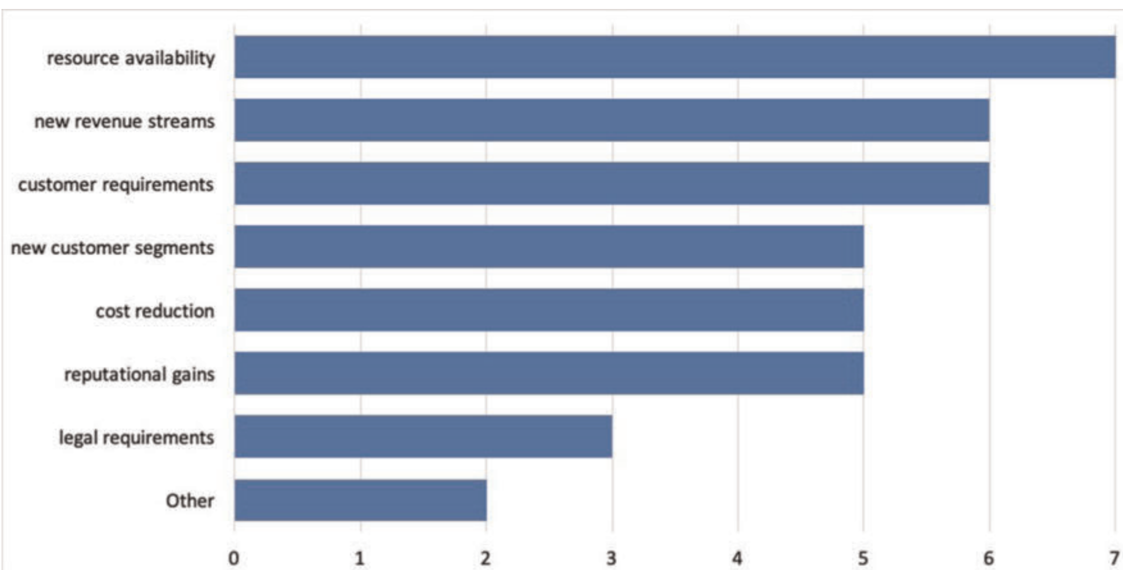
To examine how motivations changed over the duration of the pilots, project leads were asked about their main motivation to take the CE approach. Financial aspects in aggregate, including new revenue streams, new customer segments, and cost reduction, were initially mentioned by 3 out of 10 respondents. Post-pilot, all 10 project leads identified at least some financial considerations as a motivation, signifying a notable increase of seven respondents. Market pull factors, such as reputational gains and legal and customer requirements, were cited by two respondents before the pilot (1 in PSS, 1 in remanufacturing) and by five afterward (4 in PSS, 1 in remanufacturing), indicating a gain of three projects with a PSS. Resource availability as motivation was initially mentioned by two and increased to five after the pilot. Aside from the market pull factors, there were no significant differences between PSS- and remanufacturing-focused pilot projects regarding their changes in motivation. Nonetheless, these findings show an increased awareness of financial aspects, market demand, and resource availability as motivators for pursuing CBMs. ▶**Fig. 2** shows all motivating

▶**Table 1** Overview of pilot projects.

Name	Type	Short description of the pilot project
Addre-Mo	R1, R2, R3, R5 (R4, R6)	Process chain development for the remanufacturing of electric bicycle motors
CbD	R0, R2, (R3, R4,) R8	New design for refrigerators, business model for cooling/freezing
CoT	R2, R7, R8	Repurposing and remanufacture in the metal industry
DiTex	R1, R2, R3, R4, R8	Logistics, sorting, maintenance, and repair of business textiles
EIBA	R3, R6	Sensor-based identification of vehicle parts for remanufacture
KOSEL	R1, R4	Modular, open-source platform for electric vehicles and sharing
LEVmodular	R1, (R2,) R4, (R6)	Small-scale serial production of light electric vehicles
LifeCycling²	R1, R3, R4, R8	Leasing and sharing concepts for electric cargo bikes
PERMA	R1, R3, R7	Furniture as a service including maintenance and remanufacture
ReLife	R4, R6	Adaptive remanufacturing for life cycle optimization of capital goods
RessProKA	R1, R3, R6, R8	Construction material rental with take-back guarantee
wear2share	R1, R4	Rental concept for clothing (private customers)

▶**Table 2** Overview of CBM experts.

#	Role	Organization
1	Circular economy and sustainable chemistry consultant	Consulting firm
2	Waste management and circularity expert	Consulting firm for due diligence, etc.
3	Circular economy consultant and lecturer	Self-employed
4	Professor of sustainable management	University of Applied Sciences
5	Circular economy project manager	National regulatory authority
6	Executive director	Sustainability research institute
7	Head researcher	Sustainability research institute
8	Senior sustainability consultant	Consulting firm
9	Professor of welfare economics	Academy of Sciences
10	Circular economy manager and researcher	Start-up and technical university



▶**Figure 2** Motivating factors mentioned by the project managers at the end of the funding measure (n = 12).

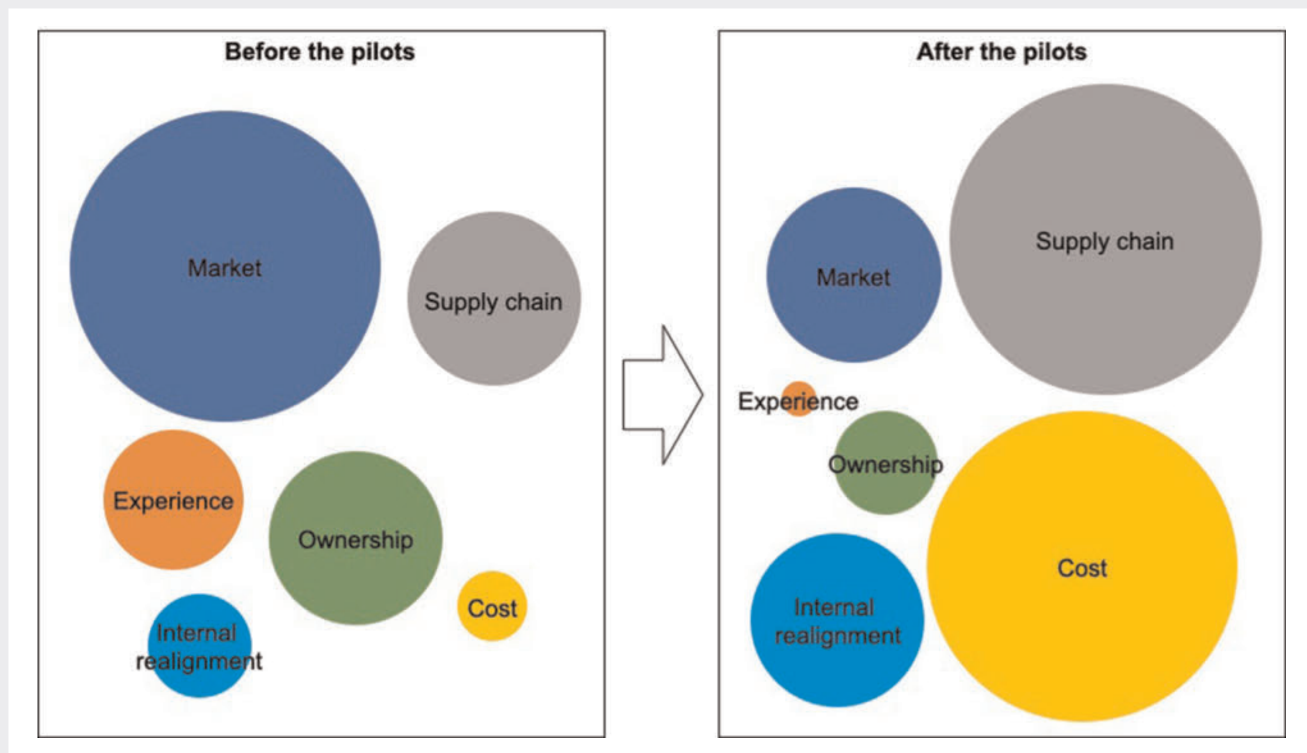
factors mentioned by the 12 project leads who filled out the post-pilot surveys.

Shifts in Perceived Challenges

Regarding initially expected and ultimately experienced challenges, project leads were asked what the main challenges for their respective CBMs were. As visualized in ▶**Fig. 3**, the findings show that, while some challenges became more prominent, others were overcome or at least reduced during the pilot projects.

Cost-related challenges, such as the cost of resources and business model implementation as well as customers' limited willingness to pay, were brought up by 2 out of 10 respondents before the pilot (1 in PSS, 1 in remanufacturing). However, post-pilot, 9 out of 10 identified such challenges, representing an increase of seven respondents that was notably driven by five additional PSS projects. Supply chain-related challenges, such as unreliable suppliers, logistical difficulties, finding suitable partners, and material disposal/reverse logistics, were initially mentioned by five respondents and increased to nine after the pilot. This rise was made up of two PSS and two remanufacturing pilots. Internal realignment challenges, including integrating secondary materials into production processes and a potential cannibalization of existing business, were noted by three respondents before the pilot and increased to five after the pilot. These findings also highlight a much more acute awareness of financial issues as well as a heightened recognition of supply chain challenges.

Market-related challenges, such as resource availability as well as customer and legal requirements, were cited by 9 out of 10 respondents before the pilot, with six from PSS and three



▶ **Figure 3** Visualized change in the weighting of challenges before and after the pilot projects. The size of the circles represents the number of responses (*n* = 10).

from remanufacturing consortia. However, after the pilot, the number decreased to 5 out of 10, with all remaining responses coming from PSS project leads, revealing a reduction driven by the four remanufacturing consortia. Experience-related challenges, such as a lack of good practice examples, were initially mentioned by four respondents before the pilot and decreased to one after the pilot, signifying a decline of three. Ownership-related challenges, including liability questions during rental periods, were highlighted by five respondents and decreased to three after the pilot.

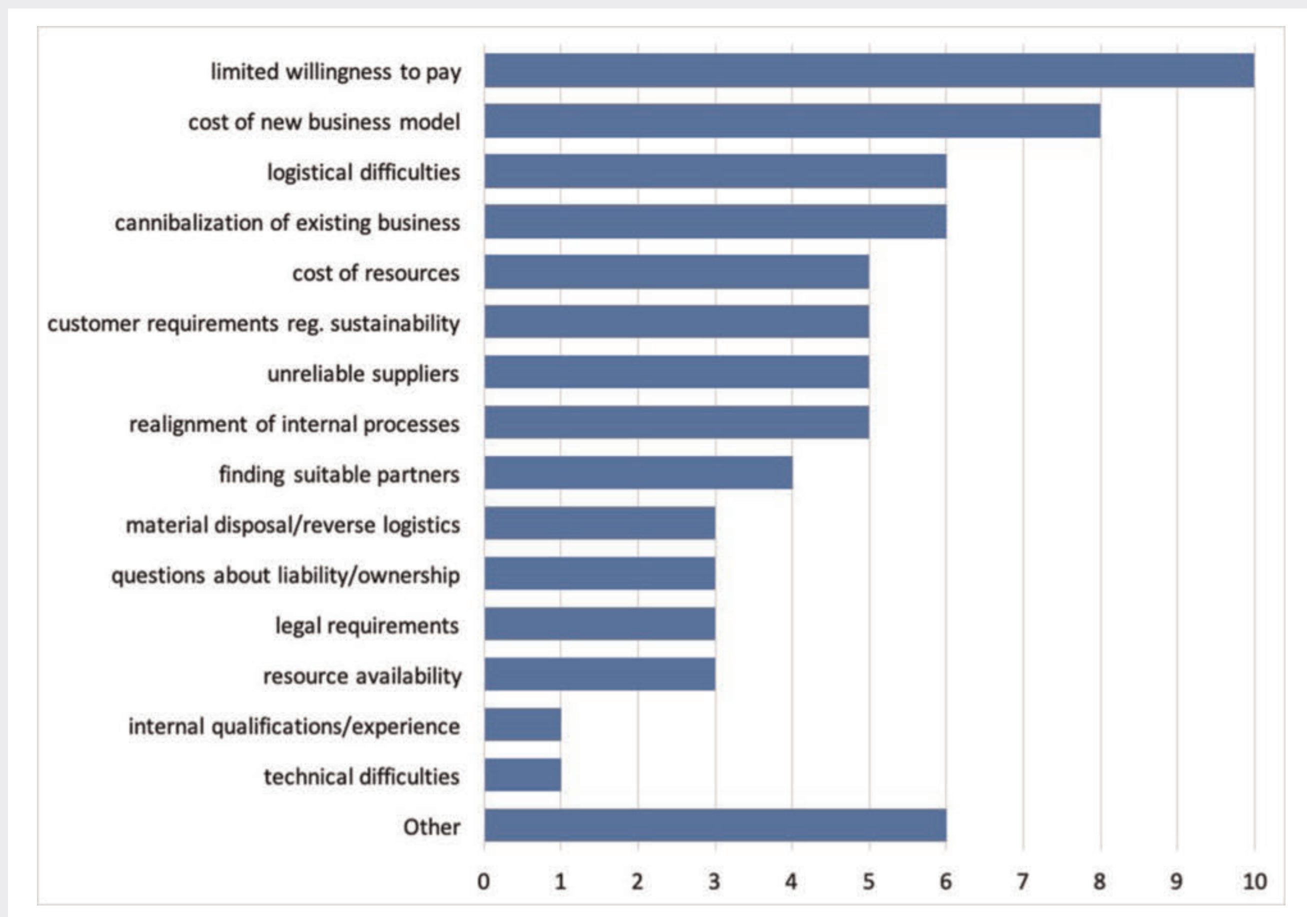
▶ **Fig. 4** shows all the challenges mentioned by the 12 project leads who filled out the post-pilot surveys. It becomes clear that financial aspects are the most prevalent issues, followed by supply chain and internal realignment issues. Other challenges mentioned by individual respondents include high complexity, profit sharing along value chains, tax-related uncertainties, and finding the right material for long-lasting products.

Shifts in Perceived Potential

To understand changes in perceived potential, project leads were asked which CE approaches or strategies they expected to have the highest potential. Before the pilot projects, there was no mention of the potential to improve the conditions for CBMs. However, after the pilot, 4 out of 10 respondents identified several aspects that should progress, such as increased value chain cooperation and transparency as well as awareness-raising. The increase was driven by one PSS pilot and three from remanufacturing. Similarly, the perception of no further potential was absent initially, but 4 out of 10 project leads expressed this viewpoint post-pilot, with three from PSS and one from remanufacturing. However, it should be noted that several partners from the remanufacturing consortium responded to the survey with a pessimistic view coming from the industrial partner, while the research partner of the consortium did see further potential. Regarding the potential related to an increased focus on upstream circularity facilitation (R0–R2), one respondent from a remanufacturing pilot acknowledged this beforehand. After, this potential was identified by four with no particular emphasis on PSS or remanufacturing pilots. These findings indicate heterogeneous outcomes of the pilot projects as some failed to see further potential while others found new possibilities such as room for improving contingencies and an increased focus on upstream activities (“Other”). ▶ **Fig. 5** shows all R strategies in the 12 project leads that filled out the post-pilot surveys saw further potential.

Discussion

In this section, the results are examined in the context of extant literature and as well as in the perspectives of the 10 CBM experts (see ▶ **Table 2**) surveyed for this purpose. Major shifts are reflected upon and possible explanations are provided by synthesizing the findings, the literature, and expert opinions.



▶ **Figure 4** Challenges mentioned by the project managers after finalizing the pilot projects (*n* = 12).

Motivation

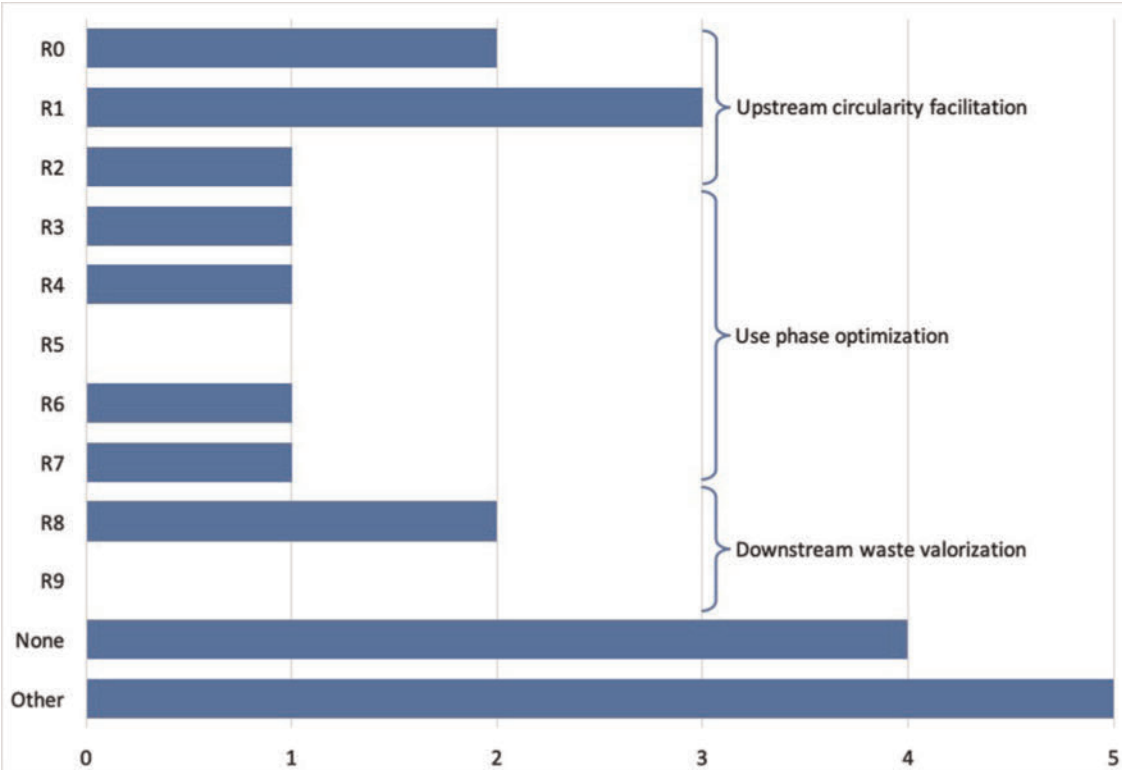
Financial considerations drastically increased in importance with one or more being named as a key motivator by all 10 project leads after the pilots had concluded. As cost-related challenges also rose significantly, this could be interpreted as a shifting perspective on CBMs from sustainability measures to legitimate business cases. More specifically, the projects may have initially been driven by nonfinancial motivators such as sustainability commitments and waste reduction targets [38]. However, when an economic lens was added during the piloting phase, opportunities of as well as threats to the CBM became clearer.

Market pull factors as motivators, such as reputational gains and legal and customer requirements, were cited by five afterward (4 in PSS, 1 in remanufacturing), indicating a gain of three projects with a PSS business model. This could be due to an *ex ante* underestimation of demand or due to general trends favoring the adoption of PSS [35]. This might initially seem to be at odds with the finding that especially PSS project leads saw no further potential after the pilots. However, the increases were noted in projects other than the ones that named market pull factors as motivators. This underlines a persisting potential of PSS under suitable circumstances [19] while they might not make sense for all products, industries, and types of customer relationships.

Challenges

The experts surveyed for this study (see ▶**Table 2**) largely agreed that the main challenges identified in ▶**Fig. 4** corresponded with their experience or expectations with some notable additions. Expert #1 mentioned the shortage of skilled workers, expert #2 differences between rural and urban contexts, expert #9 pointed to misleading or incomplete environmental regulation, while expert #10 saw customers' apprehension to new business models as an additional challenge. Expert #8 added that willingness to pay for more sustainability should not be an issue as successfully implemented CBMs should be cheaper for customers than linear ones, thereby alluding to potentially necessary changes to the respective pilot projects' business models.

Incorrect initial assumptions were named by eight experts as a key reason for the larger shifts observed in ▶**Fig. 3**. On the one hand, expert #1 stressed that supply chain issues tend to be underestimated, especially by business people with less practical experience. On the other hand, expert #4 mentioned that initial expectations may have overestimated cost savings and revenue



▸ **Figure 5** Opportunities to extend the business model with more R strategies in the perception of the projects after the end of the program (n = 12).

gains. This was echoed by experts #6 and #7 who suspect common but wrong assumptions about the profitability of CBMs, especially when evaluated against a business-as-usual scenario in markets shifting toward sustainability. Expert #10 confirmed this from the experience with his own start-up: The focus on costs and supply chain only comes with "real life" insights.

Increasing Challenges

The PSS-driven surge in perceived cost-related challenges indicates that the cost of such business models might be difficult to gauge in advance. Additionally, initial investments for CBMs tend to be high in general [16, 21]. Coupled with the concept of multiple uses (e.g., via rental) over extended time periods instead of a single sale, the amortization of PSS might take longer. Expert #4 also mentioned this cash flow problem during the transition to CBMs. Expert #2 connected the cost of PSS with their complex logistics, while expert #10 concluded that remanufacturing-based business models might be easier to calculate and, therefore, predict than those revolving around PSS.

Taking a closer look at the increase in supply chain-related challenges, experts #4 and #5 see a persisting information deficit as a possible explanation while experts #6 and #7 pointed to the essential need for collaboration in a CE which can also be found throughout literature [2, 22]. Rising awareness of this crucial component of CBMs could therefore explain the shifting perspective on supply chain issues.

Perceived challenges related to internal realignment increased from 3 to 5 respondents. While there was no notable difference in responses from remanufacturing and PSS projects, it highlights that CBMs require systemic changes to reach their full potential [3]. Conversely, circular pilot projects in organizations that otherwise operate according to a linear economic model might have lower chances of success.

General trends such as rising costs and maturing markets for sustainable alternatives were also mentioned as potential explanations for the shifts in perceived challenges by experts #2 and #3.

Decreasing Challenges

The remanufacturing-driven reduction in market-related challenges from 9 to 5 out of 10 suggests that perceived initial issues seem to have been resolved more easily for remanufacturing CBMs than for those implementing PSS. Several experts agreed that PSS involves a higher level of complexity due to long-term customer relationships (expert #1), farther-reaching implications for value chains (experts #6, #7, #10), and significant changes in financial models (expert #8). The success of PSS was also said to be contingent on factors such as population density (expert #2), the type of product and service provided, and their significance to the user (expert #3) as well as their overall competitiveness (expert #9).

Mentions of experience-related challenges, like a lack of good practice examples, declined from four respondents to one respondent after the pilot. This can be attributed to new knowledge that was likely gained throughout the piloting phase and shows the effectiveness of pilot projects in terms of building competencies and capabilities for CBMs.

Ownership decreased from 5 to 3 with no clear emphasis on remanufacturing or PSS projects, before as well as after the piloting phase. Expert #2 highlighted the relevance of circumstance by stating that owning products is less relevant in an urban context where there are more people with whom products can be shared over shorter distances. However, this may be more applicable to business-to-customer (B2C)-focused CBMs.

Experts #6 and #7 noted that it was interesting how challenges related to ownership, market, and experience were less mentioned and posited that it might show a willingness to accept a more collaborative work system. Expert #8 added that this shows that the key issue is not the market but the implementation of CBMs. Furthermore, experts #6 and #7 highlighted the need to complement these practical experiences with a more systemic, context-oriented discussion on the impacts of issues related to ecosystem resilience, resource stewardship, and changing consumer behaviors.

Potential

The perception of no further potential by three PSS and one remanufacturing project after the pilot is in line with the finding that PSS faces higher organizational and financial barriers than other CBMs [39]. Besides agreeing with the challenges posed by complexity, some experts also identified a generally waning enthusiasm for PSS. Experts #1 and #4 added that PSS has been around for a while now but has failed to gain momentum due to varying success while remanufacturing requires fewer changes to existing business models and value chains. Thus, perception of further potential is easier in the case of business models based on remanufacturing, as outlined by expert #10.

After the pilot, one PSS and three remanufacturing project leads identified potential for stronger value chain cooperation and transparency as well as awareness-raising. Remanufacturing pilots may thus have been more affected by external factors that need improvement while PSS may have been affected more by internal factors such as cost/profitability [39]. Expert #8 found this surprising at first but hypothesized that ideas for improving framing conditions could also be a sign of interest in the respective business model.

An increased focus on upstream circularity facilitation after the pilots can be explained by a potential realization that design impacts the subsequent circularity and sustainability potential and is therefore a crucial step when implementing CE practices [27].

Conclusion

This study examines the progressing perspectives of consortia from before to after piloting CBMs, with a focus on PSS and remanufacturing business models. In particular, significant changes were observed in motivation, perceived challenges, and potential ascribed to the piloted CBMs.

Firstly, the study found that CBM pilots serve as valuable opportunities for organizational learning [1]. On the one hand, it suggests that implementing PSS alongside LBMs can pose challenges, requiring extensive organizational changes to address the added complexity. On the other hand, remanufacturing practices seem to be easier to implement due to their predictability and compatibility with existing business models. CBM pilots should allow flexibility for pivoting business models to ensure long-term circularity and financial success. The learning here is that this economic consideration should be reiterated during the process—not too early to block innovative ideas, yet not too late as it can lead to disillusionment. A sensible approach for practitioners may be to avoid determining the type of CBM *ex ante*, but to successively build the business model that best achieves circularity and sustainability within the given organizational context.

Secondly, the study shows big differences between the initial and subsequent perceptions of challenges, especially regarding the cost of resources and the new business model. This may be connected to a potential need for high initial investments in infrastructure supporting complex circular value chains. Regarding the reported shifts in challenges, the findings indicate that the market is increasingly ready for CBMs, hinting at a positively progressing context. The pilot projects have provided valuable experience and addressed ownership-related questions. At the same time, cost issues remain and the required changes in supply chains and internal organization still need further attention.

Thirdly, funding schemes for pilot projects focusing on business models seem to require some aspects that differ from technology-focused funding schemes on which viable business models are built at a later point. Creating business models without a tested value proposition may be a promising approach for promoting circularity in established companies, however, a rough profit and loss account should be provided at the start of the project. This can serve as a baseline which is then regularly adjusted to account for the ongoing organizational learning.

This study provides valuable insights into the motivators, challenges, and potential of piloting CBMs. By understanding the dynamics of organizational learning, the timing of economic considerations, and the complexities of PSS implementation, practitioners and researchers can work toward more effective and sustainable circular business practices.

Limitations and Further Research

The findings of this study must be interpreted within the context of several limitations. The diverse portfolio of pilot projects examined does not allow for generalizations and the focus of the study on European and specifically German contexts may limit the applicability of the results to other regions or contexts. Additionally, the reliance on various qualitative data sources for the analysis necessitates interpretation by the authors, introducing the potential for bias.

Moreover, it is important to acknowledge the impact of the COVID-19 pandemic on the pilot projects. The pandemic may have intensified certain outcomes, such as an increased focus on costs due to rising prices and an increased awareness of supply chain challenges. These external factors may have influenced the findings and should be considered when interpreting the results.

Sustainable business models must have both ecological and economic advantages over conventional business models. In the context of CBMs, there is a risk of rebound effects which can limit their sustainability [42]. These effects occur when material efficiency gains are offset by higher greenhouse gas emissions or biodiversity loss. Throughout the pilots, attention was paid to potential interdependencies and rebound effects between various environmental factors. A reasonable next step would therefore be to use the results of this evaluation and the assessment of ecological advantages and disadvantages for these projects (cf. [15]) to explore correlations between the two dimensions.

Future research could include a meta-study of CBM case studies to derive more generalizable results. Such a study would provide a comprehensive overview of CBM implementations across different contexts, allowing for more robust conclusions and recommendations for practice and policy. Another worthwhile endeavor could be a comparison of pilot projects with and without a CE focus regarding the developing perspectives on motivations, challenges, and potential. This would help to single out the aspects specific to CE pilots while sorting out the ones that are simply symptoms of pilot projects in general.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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