

Collaboration towards the design of sustainable and circular value chains: reviewing the state-of-the-art in literature and practice

Giliam Dokter^(a), Adam Mallalieu^(a), Sophie Isaksson Hallstedt^(a) Ola Isaksson^(a)

a) Chalmers University of Technology, Department of Industrial and Materials Science, Division of Product Development, Göteborg, Sverige

Keywords: Sustainability, circular economy, collaboration, circular value chains, circular ecosystems

Abstract: The transition to a circular economy (CE) is essential for extending product lifespans and maximizing resource use, contributing to resource efficiency and sustainability. Circular solutions demand extensive collaboration across the value chain, encompassing suppliers, distributors, and consumers. Based on a review of literature and existing frameworks for the design of circular value propositions, this study investigates key factors enabling collaboration within circular value chains and evaluates the extent to which existing frameworks address value chain collaboration. Nine key factors for collaborative circular value chains were identified: sustainability leadership, value mapping, shared vision building, trust-building, collaborative governance, collaborative processes, ecosystem perspectives and orchestration, and monitoring and evaluation. The analysis of 38 frameworks showed strong focus on value chain collaboration, but the ecosystem perspective and links to digitalisation and data sharing were underrepresented. The research highlights the role of collaborative governance and ecosystem orchestration in addressing challenges such as stakeholder engagement, data management, and balancing competitive and collaborative interests. Future research should focus on developing tools and frameworks that emphasize the intersection of sustainability, circularity, value chain collaboration, and digitalisation and data management. Comprehensive approaches are needed to help manufacturers develop capabilities for sustainable circular ecosystems, aligning roles and incentives between partners, facilitating collaboration and co-creation, and enhancing data sharing and management. The findings contribute to a deeper understanding of the factors necessary for sustainable collaborative circular value chains, providing a foundation for further research and practical guidance for industry.

Introduction

The transition towards a circular economy (CE) is vital for prolonging product lifetimes and ensuring that materials are kept at their highest utility and value for as long as possible. In turn, this can contribute to more efficient use of resources and potentially a more sustainable society. With increasing pressure from policies and consumers, product manufacturers in the EU are increasingly exploring how to (re)design their products and business models in line with a CE. One of the main challenges of extending product lifetimes and closing resource loops is the collaboration required throughout the value chain (Geissdoerfer et al., 2018). Wider value chain collaboration is needed to facilitate the extended use and circulation of resources, but also to enable the sharing of product-related information between actors. Product manufacturers cannot meet circularity requirements and identify the most effective measures for product lifetime extension, if they

lack access to reliable and accurate information about the composition of their components and materials. In the automotive sector for example, gathering reliable information can be challenging due to the sheer number of parts, number of suppliers extending across multiple tiers, and lack of transparency. Supplier information is crucial to meet the EU's upcoming requirements regarding the design and end-of-life management of vehicles (e.g., including dismantling instructions, circularity passports, and 25% of recycled plastics in new vehicles) (European Commission, 2023). Recent research has highlighted the necessity of innovating towards *circular ecosystems*, with the purpose of changing how a set of actors interact to achieve circularity as a collective outcome (Konietzko et al., 2020). Digital product passports (DPP) are proving instrumental in these efforts, and recent advancements in collaborative data ecosystems and product traceability platforms (e.g., *Catena X*, n.d.; *Circularise*, n.d.)

demonstrate the potential of novel digital technologies to enable decentralised information exchange, overcome issues related to data sharing and trust, and enhance traceability. Yet another question that remains is how to – during the product development process – create and foster conditions for collaborative circular value chains, and what are factors that should be considered? While the importance of collaboration for a CE is apparent, there is still a lack of knowledge regarding the conditions and capabilities, despite efforts made (see e.g., Brown et al., 2021; Köhler et al., 2022), which foster successful value chain collaboration. Moreover, there is a need to understand whether available prescriptive frameworks for the design of circular value propositions aid companies in facilitating collaboration and overcome challenges towards sustainable and circular value chains. Therefore, this paper aims to (1) identify enabling factors for collaboration in circular value chains, and (2) evaluate to what extent value chain collaboration is integrated in existing frameworks targeted towards the development of circular value propositions. This research was conducted in multiple steps. First, we deploy a literature review to identify enabling factors for collaborative circular value chains. Second, we reviewed existing frameworks that support the development of circular value propositions, to investigate to what extent these address value chain collaboration. We conclude this paper by discussing our findings from the literature and the tool review, followed by recommendations for the development of design support to facilitate collaboration towards sustainable and circular value chains.

Methods

Literature review

A scoping review (Arksey & O'Malley, 2005) was performed to summarize relevant literature related to collaboration for circular value chains and extract enabling factors, as well as clarify research gaps and working definitions. The review focused on journal articles published from 2015 and onwards. Subsequently, the CE concept gained significant traction in research in policy. Three sources were utilised (Scopus, Web of Science, and Google Scholar) to identify relevant articles through a combination of search strings including: Circular,

Sustainability, Value chain, Supply chain, Collaboration, co-design, and co-creation. First, 133 articles were identified and assessed on relevance by examining titles, keywords, and abstracts. Next, 45 articles were excluded due to lack of relevance, and 88 articles were reviewed, summarised, classified according to type, and assessed on relevance. Finally, articles of high relevance were read in detail (47 articles) and relevant factors for the development of collaborative circular value chains were extracted.

Practice review

An online search was conducted to identify prescriptive frameworks that focus on the design of sustainable and circular value propositions. The frameworks were identified ad-hoc and were gathered over a period spanning from September 2021 to March 2024. A total of 38 prescriptive frameworks were identified originating from manufacturers, consultancies, and NGOs. Recurrent themes in the literature review informed the development of a classification framework for the practice review. The frameworks were classified according to focus, type of intervention, and ecosystem elements. The classification framework ensured a systematic approach in evaluating the focus and scope of the frameworks and examine to what extent aspects related to sustainable and circular ecosystems, and value chain collaboration were integrated. The results were collaboratively reviewed and discussed among the authors to extract and refine key insights.

Findings and discussion

In the following section, we report and discuss our findings from the literature review and tool review, respectively. Furthermore, we outline some directions and recommendations for further research.

Factors for collaborative sustainable and circular value chains

Based on the literature review, enabling factors and corresponding actions for the development of collaborative sustainable and circular value chains were identified and clustered into themes. The themes identified related to

sustainability leadership, value mapping, shared vision building, building trust, collaborative governance, collaborative processes, ecosystem perspectives and orchestration, and monitoring and evaluation. Figure 1 provides a summarized overview of the enabling factors for collaborative sustainable and circular value chains (see Table 1 in appendix for explanations of each theme and corresponding references). A recurrent theme in the review was the notion of circular ecosystems, illustrated by the fact that ‘ecosystem’ appeared in 18 of the 88 reviewed abstracts. How circular ecosystems contribute to the three dimensions of sustainability remains somewhat unclear as the concept is not clearly defined and multiple interpretations exist (Trevisan et al., 2022). We align with (Konietzko et al., 2024), who notes that *“newly emerging innovation ecosystems for circularity should aim for positive value and impact across the social, environmental and economic dimensions.”* Challenges for such ecosystems are involving relevant stakeholders, identifying shared benefits of a circular proposition, establishing a shared data platform (a necessity to measure progress towards circularity), and the management and orchestration of involved stakeholders (Konietzko et al., 2024). While innovation ecosystems address radical innovation and new markets through primarily temporary project-based efforts (Adner, 2006), circular ecosystems require continuous long-term partnerships focused on sustainable and closed resource loops through shared responsibility and collective resource management, necessitating greater transparency, integration, and information sharing across the entire value chain. In the absence of formal approaches and established standards to guide circular ecosystems, there are significant challenges and trade-offs between knowledge and information sharing, and intellectual property and competitive advantage (Köhler et al., 2022). In turn, this further emphasizes the importance of collaborative governance (i.e., formal agreements and rules for collaboration, accountability, and decision-making). Overall, the review indicated several gaps in the research focused on collaborative sustainable and circular value chains. First, while the role of novel digital technologies and technology providers in fostering circular value chains has been studied, there is currently limited research examining how these technologies and

9 factors for collaborative circular value chains



Figure 1. Overview of factors extracted from the literature review. The diagram provides an overview and does not intend to suggest a specific order in which activities should be undertaken.

providers facilitate value chain collaboration aside from (Gebhardt et al., 2022a; Schögl et al., 2023), and how they foster the conditions and capabilities for successful collaboration over time. Second, while there are some prescriptive frameworks for the co-development of circular value chains (Blomsma, Pigosso, et al., 2019; Santa-Maria et al., 2022), few provide

practical guidance or iterative approaches on how to go about the involvement of external stakeholders in the development of a sustainable and circular value proposition, and how to guide stakeholder co-creation and the aforementioned challenges related to sustainable and circular ecosystems. Third, though some studies have examined the role of circular ecosystem orchestrators (Hansen & Schmitt, 2021; Marques-McEwan et al., 2023; Trevisan et al., 2022) there is still a limited understanding of what type of actors are best suited to take this role and how these orchestrators influence the effectiveness of

value chain collaboration and co-creation. Marques-McEwan et al. (2023) notes that technology companies (e.g. companies that facilitate resource recovery or a data ecosystem) can initially take the role of ecosystem orchestrator, and that the role likely changes over time from the technology provider to the product owner. Moreover, factors such as collaborative efficacy, distribution of agency and power, reciprocity, and setting (on-site, online) could also play a role in collaborative circular value chains (Berardi & Brito, 2021; Marquina et al., 2024).

Frameworks supporting collaborative circular value chains

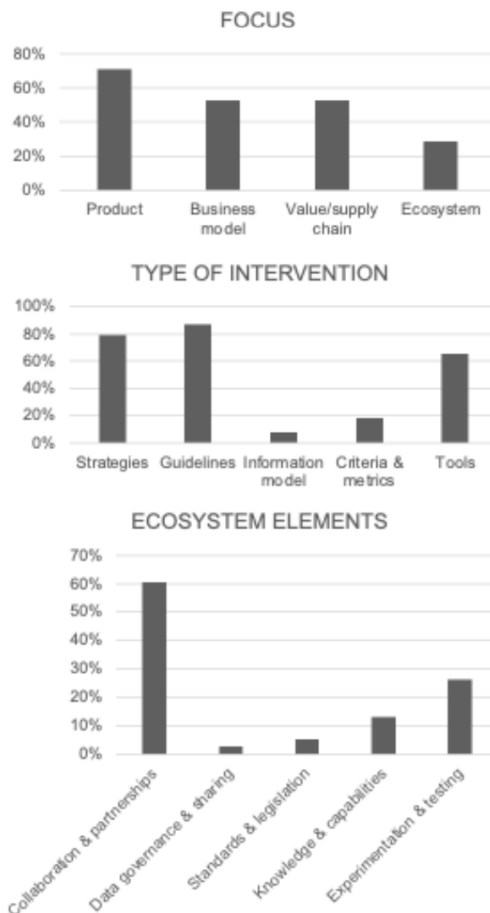


Figure 2. Exploration of frameworks for developing circular value propositions classified by focus, type of intervention, and ecosystem elements.

Figure 2 provides an overview of the reviewed 38 existing frameworks for the design of circular value propositions. The findings indicated that

most frameworks focus on individual ecosystem elements (i.e. products, business model, or value chain) and fewer take an ecosystem approach (i.e., the combination of product, business model, and value chain) to the development of sustainable and circular value propositions. While many frameworks focused on elements of value chain collaboration and partnerships (58%), few also included considerations regarding digitalization and data sharing and governance (3%). Around 80% of the reviewed interventions entailed proposed strategies and guidelines, while fewer focused on criteria and metrics (19%) and information models (8%).

Comparing findings and future research

Much of the examined literature advocates a holistic or ecosystem approach to the development of a circular product, business model, and value chain. The reviewed frameworks primarily focus on individual elements (product, business model, or value chain) and do not comprehensively address the combination of these elements. It should be noted that the notion of circular ecosystems has advanced substantially in recent years (Trevisan et al., 2022) and many of the gathered tools were conceptualized before 2020. The findings also indicated that a majority (60%) of the reviewed frameworks incorporated elements related to value chain collaborations and partnerships. Yet, the connection between collaboration and digitalisation in value chains remains underexplored in both the literature and frameworks, particularly in terms of clarifying roles and incentives in sustainability-related data sharing and management. As already pointed out by (Baumgartner et al., 2024), issues related to data sharing and transparency can potentially be overcome through novel digital technologies that can enable confidentiality-preserving and trustworthy environments. Furthermore, (Schögl et al., 2023) provided evidence that digital technologies positively affect interorganizational collaboration in CE efforts. Overall, few frameworks provide a comprehensive approach or formal process that guide organizations through the steps of

developing a circular product and business model, including key considerations for the involvement of external stakeholders and successful value chain collaboration. Some examples are the circular design guide (Ellen MacArthur Foundation & IDEO, 2017) and the CIRCit workbooks (Kravchenko et al., 2020) that provide tools and practical guidance to address different challenges towards sustainable and circular ecosystems where different steps may be conducted with diverse actors. Extending product lifetimes and promoting practices such as repair, refurbishing, and remanufacturing require collaborative ecosystems of stakeholders – including manufacturers, material suppliers, service providers, and technology providers, who are aligned through shared responsibility, clear incentives, and long-term partnerships. Novel collaborative value chain partnerships are vital in managing product lifetimes, for example in enhancing material recovery and disassembly processes (Nußholz, 2018). To support product lifetime extension and circularity – there is a need to provide practical and clear guidance on how to foster and structure long-term value creating partnerships with value chain actors, through clarifying roles and incentives, trust-building mechanisms, collaborative structures, and data sharing frameworks. Therefore, future research will focus on comprehensive approaches toward mapping (existing and needed) stakeholders, resource flows, data and information flows, and capabilities for a sustainable and circular ecosystem. The readiness of diverse ecosystem actors regarding maturity in collaboration, sustainability and circularity, and data management is of key importance here, as this may steer the approach and collaborative process. Based on such an ecosystem mapping, guidance can be provided in understanding what capabilities and corresponding new partnerships and collaborations are needed, which guide what relevant stakeholders to strategically involve.

Conclusions

Based on a literature review and a review of existing frameworks, this study provides insights into factors that enable collaboration for sustainable and circular value chains and explores to what extent value chain

collaboration is addressed in existing frameworks targeting the design of circular value propositions. The present research identified 9 factors for collaborative sustainable and circular value chains. These include sustainability leadership, value mapping, shared vision building, building trust, collaborative governance, collaborative processes, ecosystem perspectives and orchestration, and monitoring and evaluation. The analysis of 38 frameworks revealed significant attention to value chain collaboration and partnerships, yet considerations regarding the connection between collaboration, digitalisation, and data sharing remain underrepresented. The concept of circular ecosystems has emerged as a pivotal framework, highlighting the interdependence of diverse actors and the need for orchestration across industrial boundaries. However, significant challenges remain, particularly in stakeholder engagement, data management, and balancing collaboration with competitive interests. The lack of formal approaches and standards that address these difficulties, underscores the crucial role of collaborative governance and ecosystem orchestrators. The findings suggest that future research, and tool development, should prioritize the interface of sustainability and circularity, value chain collaboration, and digitalization. Particularly the role and influence of ecosystem orchestrators in enabling successful value chain collaboration and co-creation needs to be further examined. Furthermore, comprehensive approaches are needed to guide product manufacturers in developing the conditions and capabilities for collaborative sustainable and circular ecosystems to overcome the inherent challenges. These should clarify and align roles and incentives in a circular ecosystem, and foster data sharing and data management capabilities. The identified themes provide a foundation for further research and may be insightful for companies in the realization of sustainable and circular ecosystems. Future research will focus on incorporating the themes in a prescriptive framework that targets the development of collaborative sustainable and circular value chains, while also examining how these themes contribute (or do not contribute) to product manufacturers achieving sustainable and circular ecosystems. There are two main limitations of the study that should be noted. First, the review of tools was not systematic and exhaustive, there may be additional tools

focusing on circular value propositions that were not part of this study (e.g., some of these are identified in a recent and more systematic review by Rexfelt & Selvefors (2024)). Second, the literature review in this study was limited to collaboration in sustainable and circular value chains, while relevant insights may also be extracted from broader literature before 2015 at the interface of sustainability and value chains.

References

- Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. *Harvard Business Review*, 84(4), 98–107; 148.
- Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, 8(1), 19–32. <https://doi.org/10.1080/1364557032000119616>
- Arnold, M. (2017). Fostering sustainability by linking co-creation and relationship management concepts. *Journal of Cleaner Production*, 140, 179–188. <https://doi.org/10.1016/j.jclepro.2015.03.059>
- Baumgartner, R. J., Berger, K., & Schöggel, J.-P. (2024). Digital Technologies for Sustainable Product Management in the Circular Economy. In T. Lynn, P. Rosati, D. Kreps, & K. Conboy (Eds.), *Digital Sustainability: Leveraging Digital Technology to Combat Climate Change* (pp. 121–143). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-61749-2_7
- Berardi, P. C., & Brito, R. P. (2021). Supply chain collaboration for a circular economy—From transition to continuous improvement. *Journal of Cleaner Production*, 328, 129511. <https://doi.org/10.1016/j.jclepro.2021.129511>
- Berlin, D., Feldmann, A., & Nuur, C. (2022). Supply network collaborations in a circular economy: A case study of Swedish steel recycling. *Resources, Conservation and Recycling*, 179(March 2021), 106112. <https://doi.org/10.1016/j.resconrec.2021.106112>
- Blomsma, F., Pieroni, M., Kravchenko, M., Pigosso, D. C. A., Hildenbrand, J., Kristinsdottir, A. R., Kristoffersen, E., Shabazi, S., Nielsen, K. D., Jönbrink, A. K., Li, J., Wiik, C., & McAloone, T. C. (2019). Developing a circular strategies framework for manufacturing companies to support circular economy-oriented innovation. *Journal of Cleaner Production*, 241. <https://doi.org/10.1016/j.jclepro.2019.118271>
- Blomsma, F., Pigosso, D. C., & McAloone, T. C. (2019). A theoretical foundation for developing a prescriptive method for the co-design of circular economy value chains. *Proceedings of the International Conference on Engineering Design, ICED, 2019-Augus(August)*, 3141–3150. <https://doi.org/10.1017/dsi.2019.321>
- Bocken, N. M. P., Rana, P., & Short, S. W. (2015). Value mapping for sustainable business thinking. *Journal of Industrial and Production Engineering*, 32(1), 67–81. <https://doi.org/10.1080/21681015.2014.1000399>
- Boldrini, J. C., & Antheaume, N. (2021). Designing and testing a new sustainable business model tool for multi-actor, multi-level, circular, and collaborative contexts. *Journal of Cleaner Production*, 309(July 2020), 127209. <https://doi.org/10.1016/j.jclepro.2021.127209>
- Brown, P., Bocken, N., & Balkenende, R. (2018). Towards Understanding Collaboration Within Circular Business Models. In L. Moratis, F. Melissen, & S. O. Idowu (Eds.), *Sustainable Business Models: Principles, Promise, and Practice* (pp. 169–201). Springer International Publishing. https://doi.org/10.1007/978-3-319-73503-0_9
- Brown, P., Bocken, N., & Balkenende, R. (2019). Why do companies pursue collaborative circular oriented innovation? *Sustainability (Switzerland)*, 11(3), 1–23. <https://doi.org/10.3390/su11030635>
- Brown, P., Bocken, N., & Balkenende, R. (2020). How do companies collaborate for circular oriented innovation? *Sustainability (Switzerland)*, 12(4), 1–21. <https://doi.org/10.3390/su12041648>
- Brown, P., Von Daniels, C., Bocken, N., & Balkenende, R. (2021). A process model for collaboration in circular oriented innovation. *Journal of Cleaner Production*, 286, 125499. <https://doi.org/10.1016/j.jclepro.2020.125499>
- Catena X. (n.d.). Catena X - Your Automotive Network. Retrieved 5 December 2024, from <https://catena-x.net/en/1>
- Chari, A., Niedenzu, D., Despeisse, M., Machado, C. G., Azevedo, J. D., Boavida-Dias, R., & Johansson, B. (2022). Dynamic capabilities for circular manufacturing supply chains—Exploring the role of Industry 4.0 and resilience. *Business Strategy and the Environment*, 31(5), 2500–2517. <https://doi.org/10.1002/bse.3040>
- Chirumalla, K., Reyes, L. G., & Toorajipour, R. (2022). Mapping a circular business

- opportunity in electric vehicle battery value chain: A multi-stakeholder framework to create a win-win-win situation. *Journal of Business Research*, 145, 569–582. <https://doi.org/10.1016/j.jbusres.2022.02.070>
- Circularise. (n.d.). Product Traceability Platform for Supply Chain Compliance. Retrieved 5 December 2024, from <https://www.circularise.com/>
- Danvers, S., Robertson, J., & Zutshi, A. (2023). Conceptualizing How Collaboration Advances Circularity. *Sustainability*, 15(6), 5553. <https://doi.org/10.3390/su15065553>
- de Pádua Pieroni, M., Pigosso, D. C. A., & McAloone, T. C. (2018). Sustainable Qualifying Criteria for Designing Circular Business Models. *Procedia CIRP*, 69, 799–804. <https://doi.org/10.1016/j.procir.2017.11.014>
- Eikelenboom, M., & de Jong, G. (2022). The Impact of Managers and Network Interactions on the Integration of Circularity in Business Strategy. *Organization & Environment*, 35(3), 365–393. <https://doi.org/10.1177/1086026621994635>
- Elia, V., Gnoni, M. G., & Tornese, F. (2017). Measuring circular economy strategies through index methods: A critical analysis. *Journal of Cleaner Production*, 142, 2741–2751. <https://doi.org/10.1016/j.jclepro.2016.10.196>
- Ellen MacArthur Foundation & IDEO. (2017). *The Circular Design Guide*. <https://www.circulardesignguide.com/>
- European Commission. (2023). *Directive on end-of-life vehicles*. https://environment.ec.europa.eu/topics/waste-and-recycling/end-life-vehicles_en
- Fernandes, S. da C., Pigosso, D. C. A., McAloone, T. C., & Rozenfeld, H. (2020). Towards product-service system oriented to circular economy: A systematic review of value proposition design approaches. *Journal of Cleaner Production*, 257. <https://doi.org/10.1016/j.jclepro.2020.120507>
- Franco, M. A. (2017). Circular economy at the micro level: A dynamic view of incumbents' struggles and challenges in the textile industry. *Journal of Cleaner Production*, 168, 833–845. <https://doi.org/10.1016/j.jclepro.2017.09.056>
- Gebhardt, M., Kopyto, M., Birkel, H., & Hartmann, E. (2022a). Industry 4.0 technologies as enablers of collaboration in circular supply chains: A systematic literature review. *International Journal of Production Research*, 60(23), 6967–6995. <https://doi.org/10.1080/00207543.2021.1999521>
- Gebhardt, M., Kopyto, M., Birkel, H., & Hartmann, E. (2022b). Industry 4.0 technologies as enablers of collaboration in circular supply chains: A systematic literature review. *International Journal of Production Research*, 60(23), 6967–6995. <https://doi.org/10.1080/00207543.2021.1999521>
- Geissdoerfer, M., Bocken, N. M. P., & Hultink, E. J. (2016). Design thinking to enhance the sustainable business modelling process – A workshop based on a value mapping process. *Journal of Cleaner Production*, 135(April 2018), 1218–1232. <https://doi.org/10.1016/j.jclepro.2016.07.020>
- Geissdoerfer, M., Morioka, S. N., de Carvalho, M. M., & Evans, S. (2018). Business models and supply chains for the circular economy. *Journal of Cleaner Production*, 190, 712–721. <https://doi.org/10.1016/j.jclepro.2018.04.159>
- Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757–768. <https://doi.org/10.1016/j.jclepro.2016.12.048>
- Guldmann, E., & Huulgaard, R. D. (2020). Barriers to circular business model innovation: A multiple-case study. *Journal of Cleaner Production*, 243, 118160. <https://doi.org/10.1016/j.jclepro.2019.118160>
- Hallstedt, S. I., Isaksson, O., & Rönnbäck, A. A. Ö. (2020). The need for new product development capabilities from digitalization, sustainability, and servitization trends. *Sustainability (Switzerland)*, 12(23), 1–26. <https://doi.org/10.3390/su122310222>
- Hansen, E. G., & Revellio, F. (2020). Circular value creation architectures: Make, ally, buy, or laissez-faire. *Journal of Industrial Ecology*, 24(6), 1250–1273. <https://doi.org/10.1111/jiec.13016>
- Hansen, E. G., & Schmitt, J. C. (2021). Orchestrating cradle-to-cradle innovation across the value chain: Overcoming barriers through innovation communities, collaboration mechanisms, and intermediation. *Journal of Industrial Ecology*, 25(3), 627–647. <https://doi.org/10.1111/jiec.13081>
- Köhler, J., Sönnichsen, S. D., & Beske-Jansen, P. (2022). Towards a collaboration framework for circular economy: The role of dynamic capabilities and open innovation. *Business*

- Strategy and the Environment*, 31(6), 2700–2713.
<https://doi.org/10.1002/bse.3000>
- Konietzko, J., Baldassarre, B., Bocken, N., & Ritala, P. (2024). Initiating a Minimum Viable Ecosystem for Circularity. In A. R. Ometto, J. Sarkis, & S. Evans (Eds.), *A Systemic Transition to Circular Economy: Business and Technology Perspectives* (pp. 65–83). Springer International Publishing.
https://doi.org/10.1007/978-3-031-55036-2_4
- Konietzko, J., Bocken, N., & Hultink, E. J. (2020). Circular ecosystem innovation: An initial set of principles. *Journal of Cleaner Production*, 253, 119942.
<https://doi.org/10.1016/j.jclepro.2019.119942>
- Kravchenko, M., Hjort Jensen, T., Pigosso, D.C.A., & McAloone, T.C. (2020). *CIRCit workbooks: Guidance towards a circular transition*. CIRCit Nord.
<https://circitnord.com/workbooks/>
- Leising, E., Quist, J., & Bocken, N. (2018). Circular Economy in the building sector: Three cases and a collaboration tool. *Journal of Cleaner Production*, 176, 976–989.
<https://doi.org/10.1016/j.jclepro.2017.12.010>
- Marques-McEwan, M., Xu, B., Bititci, U. S., & Jiang, M. (2023). Unveiling the rules for creating circular business ecosystems: A case study in the chemical industry. *Journal of Cleaner Production*, 427, 139185.
<https://doi.org/10.1016/j.jclepro.2023.139185>
- Marquina, M. V. H., Le Dain, M.-A., Joly, I., & Zwolinski, P. (2024). Exploring determinants of collaboration in circular supply chains: A social exchange theory perspective. *Sustainable Production and Consumption*, 50, 1–19.
<https://doi.org/10.1016/j.spc.2024.07.017>
- Nußholz, J. L. K. (2018). A circular business model mapping tool for creating value from prolonged product lifetime and closed material loops. *Journal of Cleaner Production*, 197, 185–194.
<https://doi.org/10.1016/j.jclepro.2018.06.112>
- Oskam, I., Bossink, B., & de Man, A.-P. (2021). Valuing Value in Innovation Ecosystems: How Cross-Sector Actors Overcome Tensions in Collaborative Sustainable Business Model Development. *Business & Society*, 60(5), 1059–1091.
<https://doi.org/10.1177/0007650320907145>
- Parida, V., Burström, T., Visnjic, I., & Wincent, J. (2019). Orchestrating industrial ecosystem in circular economy: A two-stage transformation model for large manufacturing companies. *Journal of Business Research*, 101, 715–725.
<https://doi.org/10.1016/j.jbusres.2019.01.006>
- Pedersen, S., & Clausen, C. (2019). Staging Co-Design for a Circular Economy. *Proceedings of the Design Society: International Conference on Engineering Design*, 1, 3371–3380.
<https://doi.org/10.1017/dsi.2019.344>
- Pedersen, S., Clausen, C., & Jørgensen, M. S. (2023). Navigating value networks to co-create sustainable business models: An actionable staging approach. *Business Strategy and the Environment*, 32(1), 240–258.
<https://doi.org/10.1002/bse.3127>
- Pieroni, M. P. P., McAloone, T. C., & Pigosso, D. C. A. (2020). Circular Economy business model innovation: Sectorial patterns within manufacturing companies. *Journal of Cleaner Production (under Review)*, 286(xxxx), 124921.
<https://doi.org/10.1016/j.jclepro.2020.124921>
- Rexfelt, O., & Selvefors, A. (2024). Mapping the landscape of circular design tools. *Resources, Conservation and Recycling*, 209, 107783.
<https://doi.org/10.1016/j.resconrec.2024.107783>
- Rijswijk, K., de Vries, J. R., Klerkx, L., & Turner, J. A. (2023). The enabling and constraining connections between trust and digitalisation in incumbent value chains. *Technological Forecasting and Social Change*, 186, 122175.
<https://doi.org/10.1016/j.techfore.2022.122175>
- Roos Lindgreen, E., Opferkuch, K., Walker, A. M., Salomone, R., Reyes, T., Raggi, A., Simboli, A., Vermeulen, W. J. V., & Caeiro, S. (2022). Exploring assessment practices of companies actively engaged with circular economy. *Business Strategy and the Environment*, 31(4), 1414–1438.
<https://doi.org/10.1002/bse.2962>
- Santa-Maria, T., Vermeulen, W. J. V., & Baumgartner, R. J. (2022). The Circular Sprint: Circular business model innovation through design thinking. *Journal of Cleaner Production*, 362, 132323.
<https://doi.org/10.1016/j.jclepro.2022.132323>
- Schögl, J.-P., Stumpf, L., & Baumgartner, R. J. (2023). The role of interorganizational collaboration and digital technologies in the implementation of circular economy practices—Empirical evidence from manufacturing firms. *Business Strategy and the Environment*, n/a(n/a).
<https://doi.org/10.1002/bse.3593>

- Sudusinghe, J. I., & Seuring, S. (2022). Supply chain collaboration and sustainability performance in circular economy: A systematic literature review. *International Journal of Production Economics*, 245, 108402.
<https://doi.org/10.1016/j.ijpe.2021.108402>
- Trevisan, A. H., Castro, C. G., Gomes, L. A. V., & Mascarenhas, J. (2022). Unlocking the circular ecosystem concept: Evolution, current research, and future directions. *Sustainable Production and Consumption*, 29, 286–298.
<https://doi.org/10.1016/j.spc.2021.10.020>

Appendix 1: Results from literature review and practice review

Table 1. Overview of key factors for the development of collaborative circular value chains extracted from the literature review.

Theme	Description	Examples of relevant references
Building trust	Building trust is crucial for collaboration and transparency in circular business model (CBM) innovation but challenging due to undeveloped standards and potential power imbalances. While formal agreements offer structure, trust through relational mechanisms is key. Strategies to overcome barriers include developing collaboration competencies, using intermediaries for data sharing, and leveraging technologies like blockchain for secure, transparent information exchange.	(Berardi & Brito, 2021; Chari et al., 2022; Danvers et al., 2023; Gebhardt et al., 2022b; Guldmann & Huulgaard, 2020; Konietzko et al., 2020; Leising et al., 2018; Marquina et al., 2024; Rijswijk et al., 2023)
Collaborative governance	Circular value chains require partnerships beyond traditional roles to enable resource recirculation and shared value. Governance, in the form of explicit rules, decision-making structures, and mechanisms such as penalties and incentives are critical for guiding collaboration and promoting sustainable behaviours. Balancing knowledge sharing with competitive advantage through IP agreements is key. Policy-driven financing and data solutions like digital product passports (DPPs) enable transparency, standardization, and trust, fostering collaboration within circular value chains.	(Brown et al., 2020, 2021; Gebhardt et al., 2022b; Hallstedt et al., 2020; Hansen & Revellio, 2020; Köhler et al., 2022; Konietzko et al., 2020; Pieroni et al., 2020; Sudusinghe & Seuring, 2022)
Collaborative processes	Pro-active collaboration, design thinking methodologies, co-design processes, and stakeholder workshops have been associated with fostering more inclusive and participatory approaches in the development of circular value propositions. Collaborative innovations depend on power dynamics and power symmetries in value chains, where power asymmetries can diminish willingness to collaborate and joint problem solving, and reciprocity can enable collaborative relationships, wellbeing, and inclusion.	(Berardi & Brito, 2021; Berlin et al., 2022; Blomsma, Pieroni, et al., 2019; Blomsma, Pigosso, et al., 2019; Franco, 2017; Geissdoerfer et al., 2016; Leising et al., 2018; Marquina et al., 2024; Pedersen & Clausen, 2019)
Ecosystem perspective	To enable the development of collaborative circular value chains it is essential that actions are taken to enable firms to adopt an ecosystem perspective. An ecosystem perspective adopts a wider and intra-organizational perspective that captures circularity as a systemic property and examines how multiple actors can direct collective efforts towards a circular value proposition to provide shared opportunities and outcomes for environmental and economic sustainability.	(Arnold, 2017; Boldrini & Antheaume, 2021; Chari et al., 2022; de Pádua Pieroni et al., 2018; Konietzko et al., 2020; Marques-McEwan et al., 2023; Sudusinghe & Seuring, 2022; Trevisan et al., 2022)
Ecosystem orchestration	Ecosystem orchestration involves an intermediary facilitating collaboration, interactions, and transactions among actors in a circular ecosystem. Orchestrators assess roles, readiness, and bridge barriers like cultural, technological, and institutional gaps. The role of orchestrator is not fixed but likely changes over time,	(Danvers et al., 2023; Hansen & Schmitt, 2021; Marques-McEwan et al., 2023; Oskam et al., 2021;

	for example from technology or service providers to the product/solution owners.	Parida et al., 2019; Trevisan et al., 2022)
Monitoring and evaluation	Monitoring and evaluation are critical for collaborative circular value chains as it provides a framework to assess current and necessary capabilities for a circular ecosystem, identify opportunities and weaknesses, and ensure alignment between stakeholders towards shared sustainability goals. Effective monitoring of readiness towards a circular value chain can create a sense of urgency amongst stakeholders, inform strategic decisions and policies, and foster transparency and accountability within a network which enhances cooperation.	(Chari et al., 2022; Elia et al., 2017; Marquina et al., 2024; Roos Lindgreen et al., 2022)
Shared vision	A shared vision (of a circular product, business model, and value chain) is crucial for collaborative circular value chains. Vision development can be enabled through joint activities with relevant stakeholders involved, to align perspectives and negotiate a shared vision. Establishing a vision is important for collaborative intent, system transformation, and long-term cooperation. Visions should be explicit statements of desired futures enabled through interactive elements such text, images, drawings, and storytelling.	(Brown et al., 2018; Hallstedt et al., 2020; Konietzko et al., 2024; Leising et al., 2018; Marquina et al., 2024)
Value mapping	It is vital to understand the perceived value of a circular solution for customers and other stakeholders, and identify shared value, ownership, and risks. Value mapping maps impacts on external stakeholders, finding positive economic interlinks between actors, and aligning solutions. Value mapping requires the identification of relevant stakeholders and flows of resources, information, and finances. The effectiveness of value mapping can depend on the tool used, and the facilitator and users.	(Arnold, 2017; Blomsma, Pieroni, et al., 2019; Bocken et al., 2015; Brown et al., 2019; Chirumalla et al., 2022; Eikelenboom & de Jong, 2022; Fernandes et al., 2020; Marques-McEwan et al., 2023; Pedersen et al., 2023)
Sustainability leadership	Sustainability leadership is crucial for collaborative circular value chains to clarify the relationship between stakeholders' efforts on circularity and sustainability goals as well as promoting structural and cultural transformation through dedicated leaders. Sustainability leaders can drive collaboration and help overcome implementation barriers on individual, organizational, value chain, and institutional levels.	(Arnold, 2017; Blomsma, Pieroni, et al., 2019; Chari et al., 2022; Hansen & Schmitt, 2021)

Table 2. Overview of analysed prescriptive frameworks for circular value propositions.

#	Name of framework	Source	Link
1	10 principles of circular design	Nike	https://www.nikecirculardesign.com/guides/MiniGuide.pdf
2	10 steps to create a circular business model	Fischer and Achterberg (2016)	https://v.fastcdn.co/u/bcd99f8d/48799320-0-finance-white-paper-.pdf
3	A quick design guide for the circular economy	Indeed (2023)	https://www.indeed-innovation.com/wp-content/uploads/2023/02/A-quick-design-guide-to-the-circular-economy.pdf
4	Beyond net zero: a systemic design approach	Design council	https://www.designcouncil.org.uk/our-work/skills-learning/tools-frameworks/beyond-net-zero-a-systemic-design-approach/
5	BM3C2 framework	University Nantes	http://www.bm3c2.fr/index.php/telecharger-trames/
6	Circulab toolbox	Circulab	https://circulab.com/toolbox-circular-economy/

7	Circular built environment playbook	World Green Building Council	https://worldgbc.org/article/circular-built-environment-playbook/
8	Circular design guide	Ellen MacArthur Foundation and IDEO (2017)	https://www.circulardesignguide.com/
9	Circular design guidelines	Stora Enso	https://www.storaenso.com/-/media/documents/download-center/documents/sustainability/storaenso_circular_design_guidelines.pdf
10	Circular design map	Switchrs	https://switchrs.com/wp-content/uploads/2021/03/Circular-Design-Map-V4.0-A4.pdf
11	Circular Design Metrics	DS Smith	https://www.dssmith.com/media/our-stories/2021/5/launch-circular-design-metrics
12	Circular Economy Business Modelling guide	CIRCit	https://www.nordicinnovation.org/sites/default/files/documents/2020/WB2_CIRCit.pdf
13	Circular product design and development	CIRCit	https://www.nordicinnovation.org/sites/default/files/documents/2020/WB3_CIRCit.pdf
14	Circular product design guide	Ikea	https://preview.thenewsmarket.com/Previews/IKEA/DocumentAssets/512088_v2.pdf
15	Circular toolkit	Danish design council	https://ddc.dk/tools/designing-your-circular-transition/
16	Circular X tools	CircularX	https://www.circularx.eu/en/tool
17	Circularity deck	Konietzko et al. (2020)	https://www.mdpi.com/2071-1050/12/1/417
18	Circulator guide	H&M	https://hmgroup.com/wp-content/uploads/2021/11/Circulator_Guide_v1.0.pdf
19	Circulytics	Ellen MacArthur Foundation (2020)	https://ellenmacarthurfoundation.org/resources/circulytics/overview?utm_term=exclude&utm_source=exclude
20	Cirkularitet: cirkulära möbler	Rise	https://cirkularitet.se/lar-dig-mer/verktyg/
21	Closing the loop by design	Utwente, Remeha BV	https://home.et.utwente.nl/designtool/5d33e8a3cfb35737ec484429954f0ea98fed69d8/index.html
22	Collaborating and networking for a circular economy	CIRCit	https://www.nordicinnovation.org/sites/default/files/documents/2020/WB6_CIRCit.pdf
23	Design manual for circular change	Wasteman team	https://www.imp.gda.pl/wasteman/download/DesignManual.pdf
24	Designing and implementing mission-oriented policies: Tools and resources from the field	UCL Institute for Innovation and Public Purpose (2024)	https://www.ucl.ac.uk/bartlett/public-purpose/sites/bartlett_public_purpose/files/designing_and_implementing_mission-oriented_policies_feb_2024.pdf
25	Designing your circular transition	Danish Design Center (2023)	https://ddc.dk/tools/designing-your-circular-transition/

26	Digital Product Passports mapping	Metabolic	https://wbcsc-dpp-mapping.metabolic.software/
27	Driving design	Distributed Design (2023)	https://distributeddesign.eu/wp-content/uploads/2023/05/DDP_DrivingDesign.pdf
28	Framework circular design	Circo	https://www.circonnect.org/framework-circular-design/
29	Future adaptive design for a circular economy	RISE	https://www.ri.se/en/what-we-do/expertises/future-adaptive-design-for-a-circular-ec
30	Guided choices towards a circular business model	Joustra (2013)	http://www.opai.eu/uploads/Guided_Choices_towards_a_Circular_Business_Model_pdf11.pdf
31	Self assessment tool	TNO, LBP, Circo	https://tno-self-assessment-tool.netlify.app/
32	Sustainability guide	SVID	https://sustainabilityguide.eu/
33	Sustainable growth with circular economy business models: A playbook for businesses	Sitra	https://www.sitra.fi/app/uploads/2022/12/sitra_sustainable_growth_with_circular_economy_business_models.pdf
34	Systemic design toolkit	Systemic design toolkit	https://www.systemicdesigntoolkit.org/download
35	The use2use design toolkit	Rexfelt and Selvefors (2021)	https://www.mdpi.com/2071-1050/13/10/5397
36	The Value Hill	Achterberg et al. (2016)	https://hetgroenebrein.nl/wp-content/uploads/2017/08/finance-white-paper-20160923.pdf
37	Upstream innovation guide	Ellen MacArthur Foundation (2020)	https://ellenmacarthurfoundation.org/upstream-innovation/overview
38	Use2use toolkit	use2use	https://www.use2use.se/