

Table 1. Identified challenges according to their topic-group with C2C-specific challenges marked

Topic-group	Challenges	Article
Product development methods	Integration of tools in product development process with extension to management models	Evrard et al. (2021), Favi et al. (2021), Filippatos et al. (2024), Jugend et al. (2020), Riesener et al. (2023), Rocha et al. (2023), Rotondo et al. (2025), Sadini et al. (2024), Vicente and Camocho (2024)
	Need for classification and collection of design tools to deal with its large number	Evrard et al. (2021), Meldrum (2023), Riesener et al. (2023), Rocha et al. (2023), Rotondo et al. (2025), Tellez Nitzling et al. (2024), Vicente and Camocho (2024)
	<i>Holistic product development tools considering business models and effective design</i>	Brusa et al. (2024), Evrard et al. (2021), Favi et al. (2021), Hildenbrand et al. (2021), Peralta et al. (2020), Rocha et al. (2023), Rotondo et al. (2025), Sadini et al. (2024), Shevchenko et al. (2024), Tellez Nitzling et al. (2024), Vicente and Camocho (2024)
	Limited use of available tools in industry due to low usability	Favi et al. (2021), Joustra et al. (2022), Jugend et al. (2020), Meldrum (2023), Peralta et al. (2020), Rotondo et al. (2025), Shevchenko et al. (2024), Tellez Nitzling et al. (2024), Vicente and Camocho (2024)
	<i>Quantitative design tools for decision-making and trade-offs for circularity</i>	Filippatos et al. (2024), Fontana et al. (2024), Rotondo et al. (2025), Vicente and Camocho (2024)
	<i>Tools addressing user behaviour/consumer engagement and feedback from EoL</i>	Filippatos et al. (2024), Fontana et al. (2024), Jugend et al. (2020), Rotondo et al. (2025), Sadini et al. (2024), Siwec et al. (2023)
	Use of LCAs complex and difficult dealing with trade-offs	Filippatos et al. (2024), Tellez Nitzling et al. (2024)
Assessment tools	Difficult selection process with time-consuming and complex application	Karkasinas et al. (2025), Saidani et al. (2020), Saidani and Kim (2021)
	Integration in digital product development process and linking with design tools	Aguiar and Jugend (2022), Aher et al. (2023), Boix Rodríguez and Favi (2024), Fang et al. (2024), Karkasinas et al. (2025), König et al. (2025), Palsodkar et al. (2024), Pluhnau et al. (2023), Ruiz-Pastor et al. (2022), Saidani et al. (2020), Saidani and Kim (2021)
	<i>Lack of specific quantitative metrics to identify potentials for circularity and value recovery</i>	Aguiar and Jugend (2022), Boix Rodríguez and Favi (2024), Ko et al. (2024), Palsodkar et al. (2024), Saidani et al. (2020), Saidani and Kim (2021)
	Holistic guidance for decision making with feedback from EoL and supply chains	Aher et al. (2023), Cappelletti and Germani (2024), Fang et al. (2024), Karkasinas et al. (2025), König et al. (2025)
	<i>Need for definitions and standardization</i>	Karkasinas et al. (2025), Ko et al. (2024), Saidani and Kim (2021)
	Complex use with detailed data for LCA and dealing with trade-offs	Karkasinas et al. (2025)
Design rules	Involving different stakeholders and disciplines with inclusion of EoL	Azua Lahidalga et al. (2024), Hoveling et al. (2024), Joustra et al. (2021), Mesa (2023a), Stölzle et al. (2023), Toxopeus et al. (2018)
	<i>Methodical support integrated in the development process with specific design catalogues</i>	Azua Lahidalga et al. (2024), Joustra et al. (2021), Mesa (2023a), Stölzle et al. (2023), Toxopeus et al. (2018)

	Need for changeable tools to deal with trade-offs and complexity	Azua Lahidalga et al. (2024), Hoveling et al. (2024), Mesa (2023a), Sangwongwanich et al. (2024), Toxopeus et al. (2018)
	Barriers in recycling and EoL of composites	Joustra et al. (2021), Sangwongwanich et al. (2024), van Doorsselaer (2022)
	Enhanced applicability of design guidelines for industrial practice	Azua Lahidalga et al. (2024), Hoveling et al. (2024), Toxopeus et al. (2018), Willskytt and Brambila-Macias (2020)
	Time-consuming use of LCAs with missing standard databases	Hakola et al. (2024), Sangwongwanich et al. (2024)
Barriers/drivers	Need for expert knowledge and available data	Chouinard et al. (2019), Horn et al. (2023), Kane et al. (2018), Pauw et al. (2013)
	<i>Lack of studies researching implementation and industry requirements</i>	Chouinard et al. (2019), Da Silva et al. (2024), Horn et al. (2023), Kane et al. (2018), Nekin et al. (2024), Pauw et al. (2013)
	<i>Involving different stakeholders and need for cooperation and feedback processes</i>	Boorsma et al. (2022), Da Silva et al. (2024), Horn et al. (2023), Ries et al. (2023)
	Existing tools are complex, time-consuming, and difficult to understand	Bakker et al. (2010), Boorsma et al. (2022), Chouinard et al. (2019), Da Silva et al. (2024), Dorrego-Viera et al. (2025), Horn et al. (2023)
	Environmental assessment and design support needed for decision-making and trade-offs	Boorsma et al. (2022), Chouinard et al. (2019), Horn et al. (2023), Kane et al. (2018)
	<i>Integration of measurements in product development process to identify critical parts</i>	Boorsma et al. (2022), Chouinard et al. (2019), Da Silva et al. (2024), Horn et al. (2023), Ries et al. (2023)
	Dealing with complex supply chains with efficient logistics	Da Silva et al. (2024), Kane et al. (2018), Ries et al. (2023)
Material selection	<i>Complex process with large number of properties/materials and missing accessible data</i>	Desing et al. (2021), Mardina et al. (2025), Mesa (2023b), Papile and Del Curto (2024)
	Compatibility with existing product development process	Papile and Del Curto (2024)
	Communication between involved departments with inclusion of EoL treatment	Mardina et al. (2025), Mesa (2023b), Papile and Del Curto (2024)
	Tools with visualization and prioritization to guide through iterative process	Mardina et al. (2025), Mesa (2023b), Papile and Del Curto (2024)
Business models	Integration of customer acceptance in sustainable business models	Cappelletti et al. (2024) Pruhs et al. (2024), Wastling et al. (2018)
	Business model selection with robust evaluation	Cappelletti et al. (2024)
	<i>Coupling of business models with design tools in product development process</i>	Cappelletti et al. (2024), Pruhs et al. (2024)
	Collaboration among supply chains and reverse logistics	Cappelletti et al. (2024)