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Circular economy and digital technology enabled innovation: Advances, applications, and prospects

Digital Technologies as Enablers of the Circular Economy: An Empirical Perspective on the Role of Companies in Driving Customer Behaviour Change

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ABSTRACT

The circular economy concept has gained significant attention in the academic and industrial discourse. Yet, the widespread adoption of circular business models is still outstanding, with a lack of customer acceptance representing a critical barrier. Recently, there has been a growing interest in the potential of digital technologies to expedite the circular economy's broader implementation. This study investigates the role of digital technologies in enhancing customer acceptance of circular business models in consumer-facing industries. To extract insights from practice, we conducted 41 semi-structured interviews with experts from companies that have implemented circular economy principles, management consulting firms, and academia. As a result, we provide thematical structures of (1) 35 factors affecting customer acceptance of circular business models, (2) 36 practices that organizations can deploy to address these factors and enhance customer acceptance, and (3) 19 digital technologies to facilitate such practices. Our findings combine and extend insights from the distinct research streams of behavioral science and theory of digital technology management by adding a technology dimension to the behavior change wheel, highlighting the interplay between sources of behavior (factors), intervention functions (practices), and technological enablers (digital technologies). This extended framework will support researchers investigating the role of digital technologies and inform companies about the use of digital technologies in circular business model innovation as an enabler of customer acceptance.

1 | Introduction

The European Union is undergoing two major economic transitions, one directed towards environmental sustainability and the other exploring the potential of digital technologies (European Commission et al. 2022). Viewing these phenomena in isolation may prohibit economies from unlocking the immense potential that inheres within a twin transition, warranting an integrated investigation of both fields (Cicerone et al. 2023; Blüm 2022; European Commission et al. 2022). In particular, the European Union deems "circularity (...) a main component of the twin transitions [that] requires a coherent technology ecosystem", highlighting the enabling role of digital technologies (European Commission et al. 2022). Unlike the present linear system that follows a take-make-dispose approach, which is unsustainable for environmental, economic,

and social reasons (Ghisellini et al. 2016; Lieder et al. 2017; Urbinati et al. 2017), the circular economy is an emerging economic system that aims to replace the predominant linear model through reducing, reusing, recycling, and recovering (Geissdoerfer et al. 2017; Stahel 2016).

While the circular economy experiences growing interest from researchers, practitioners, and policymakers (Pieroni et al. 2019), the implementation of circular business models is still limited (European Environment Agency 2019; Gülserliler et al. 2021; Stahel 2016). This is a challenge since national agendas are set on recovering their economies in the post-Covid era through more circularity across industries (European Environment Agency 2019; Renda et al. 2021). Hence, the scalability of circular business models across consumer markets will be crucial in transitioning towards more sustainable economies. However, the lack of customer acceptance of circular business models is perceived as a critical barrier to the implementation of the circular economy (Kirchherr et al. 2018), thus requiring customer-centric innovation (Bernon et al. 2018; Linder and Williander 2017). This study will focus specifically on end-consumers, as suggested in previous studies (Bigerna et al. 2021; Bocken and Konietzko 2022; Charnley et al. 2022; de Jesus and Mendonça 2018; Huynh 2021).

Digital technologies are increasingly recognized as critical enablers of the circular economy (Chauhan et al. 2022; Kumar et al. 2020; Ranta et al. 2021; Toth-Peter et al. 2023). While a growing body of literature focuses on customer acceptance of circular business models, research on how companies leverage digital technologies in circular business model innovation to enhance customer acceptance in consumer-facing industries is fragmented (Bressanelli et al. 2021; Chauhan et al. 2022; Ranta et al. 2021; Toth-Peter et al. 2023) and lacks empirical research (Centobelli et al. 2020; Lopes de Sousa Jabbour et al. 2018).

This study will address this gap and explore the role of digital technologies as an enabler of the circular economy with a focus on customer acceptance of circular business models empirically by addressing the following research question: "How do consumer-facing companies in the circular economy use digital technologies to enable customer acceptance of their circular business model innovations?"

We employ an exploratory approach by drawing on data from 41 semi-structured expert interviews with representatives from companies with circular business models, management consulting firms, and academia. In doing so, we develop comprehensive thematic structures on factors affecting customer acceptance, practices for enabling customer acceptance, and digital technologies used to facilitate such practices. Building on the behaviour change wheel framework from Michie et al. (2011) and the digital technology layers from Guo et al. (2020), we discuss otherwise separate research streams and develop an extended theoretical framework, highlighting their interrelationship. Combining research on circular economy and digital technologies, this study contributes to circular business model innovation and customer behaviour theory, showcasing that the levers companies can adopt using digital technologies to drive change in customer behaviour for their circular business model innovations.

The remainder of this study is structured as follows. Section 2 highlights the relevant theoretical background on the circular economy, customer behaviour in the circular economy, and digital technologies as an enabler of the circular economy. Section 3 outlines the methodological approach, and Section 4 highlights the study's results. Section 5 uses these results to develop an extended theoretical framework, assesses its applicability, and discusses the study's contribution to theory and practice. Finally, Section 6 provides concluding remarks on the study's limitations and suggests avenues for future research.

2 | Theoretical Background

2.1 | The Role of Customer Behaviour for Circular Business Models

The implementation of the circular economy requires a fundamental transformation of product offerings, services, channels, and customer relations (Bocken and Konietzko 2022; de Jesus and Mendonça 2018; Demirel and Kesidou 2019) and the development and innovation of circular business models (Bocken and Konietzko 2022; Linder and Williander 2017). Geissdoerfer et al. (2020, 7) describe businesses with circular business models as those "that are cycling, extending, intensifying, and/or dematerialising material and energy loops to reduce the resource inputs into and the waste and emission leakage out of an organisational system". They describe companies' value proposition, creation and delivery, and capture as processes involving the implementation of various activities internally and building relationships externally with supply chain stakeholders, such as customers, to slow, narrow, and close resource loops (Bocken et al. 2016; Geissdoerfer et al. 2018; Osterwalder and Pigneur 2010; Richardson 2008; Urbinati et al. 2017). Therefore, the successful implementation of the circular economy is ultimately dependent on the customer, as the final decision maker that accepts or rejects a circular business model (Ertz et al. 2019; Kirchherr et al. 2017; Saidani 2022; Salvador et al. 2020).

2.2 | Customer Acceptance of Circular Business Models

While significant advances were made on the technical side of circular business models, the lack of customer acceptance of these business models has been identified as a key barrier to the transition towards the circular economy (Govindan and Hasanagic 2018; Khor and Hazen 2017; Kirchherr et al. 2018; Wang and Hazen 2016). Since then, multiple publications have addressed customer acceptance (Mugge et al. 2018; Singhal, Tripathy, et al. 2019). These studies usually focus on factors affecting customer acceptance, that is, drivers or barriers of acceptance, such as quality, convenience, or price (Hazen et al. 2017; Rexfelt and Hiort 2009; Van Weelden et al. 2016). Factors such as these are strongly connected to the design of a company's circular business model. For example, the business model's value proposition affects the customer's perception of quality, its value creation and delivery affect their perception of convenience, and its value capture influences their perception of price. Previous overviews of such factors include the works of Islam et al. (2021) and Singhal, Jena, et al. (2019).

While most studies are focused on the above factors affecting customer acceptance, only a few studies have started highlighting the role of practices that companies can deploy to overcome such challenges and enhance acceptance (Bressanelli et al. 2019; Charnley et al. 2022; e.g., Govindan and Hasanagic 2018). Companies need to rethink their practices towards their customers, forming closer relationships and involving them in their decision-making (Lopes de Sousa Jabbour et al. 2023; Saidani 2022). For example, companies can influence their customers' perception of price, which is related to the value capture element of a business model, by making strategic changes to their circular business models, such as adapting the pricing for circular offerings and offering take-back incentives or by enhancing awareness through communication (Bressanelli et al. 2019; Charnley et al. 2022; Govindan and Hasanagic 2018).

The European Environment Agency notes that "consumer behaviour is one of the key levers for enabling the transition to a circular economy" (European Environment Agency 2019, 25). However, behavioural aspects and the customer's role in circular economy implementation remain underexplored (Dubey et al. 2021; Gebhardt et al. 2021; Sarkis 2020). Hence, researchers need to consider a more customer-focused perspective on circular business models (Kirchherr et al. 2017; Saidani 2022; Salvador et al. 2020), This study follows the call urging "researchers [...] to explore the implementation of the circular economy through identifying the drivers, barriers, and practices" (Govindan and Hasanagic 2018, 307). This highlights a gap in the current literature and suggests the need for further research to identify factors affecting customer acceptance, which can be drivers or barriers, and practices that companies can deploy to address such factors and enhance customer acceptance for their circular business models. Definitions for key terminologies, as mentioned above, can be found in Table 1.

The behavioural sciences offer several frameworks for analysing and influencing behaviour. The behaviour change wheel, developed by Michie et al. (2011), is a widely used concept based on 19 different behaviour frameworks. These include the "taxonomy of behaviour change techniques" (Abraham et al. 2011), "intervention mapping" (Bartholomew et al. 2011), or "implementation taxonomy" (Leeman et al. 2007). In their systematic analysis, Michie et al. (2011) identify shortcomings of these behaviour intervention frameworks in terms of comprehensiveness and conceptual coherence and construct a new framework that builds on existing ones to overcome their limitations. At the centre, the wheel recognises three components as sources of behavioural change: capability, opportunity, and motivation. Michie et al. (2011, 4) define these components as follows: capability constitutes "the individual's psychological and physical capacity to engage in the activity concerned" and includes "the necessary knowledge and skills". Motivation constitutes "all those brain processes that energise and direct behaviour, not just goals and conscious decision-making", including "habitual processes, emotional responding, as well as analytical decision-making". Opportunity constitutes "all the

TABLE 1 | Definition of key terms.

Term	Definition	Source
Circular economy	A regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling	Geissdoerfer et al. (2017, 6)
Circular business models	Circular business models can be defined as business models that are cycling, extending, intensifying, and/or dematerialising material and energy loops to reduce the resource inputs and the waste and emission leakage out of an organisational system	Geissdoerfer et al. (2020, 7)
Customer acceptance	The positive decision of a customer based on their intention and behaviour towards the purchase of a product or service and the post-purchase evaluation phase, which is affected by a range of influencing factors. This can be achieved by purchasing and positively evaluating a product or service that is long-lasting by design and that is maintained, repaired, reused, remanufactured, refurbished and/or recycled repeatedly during its lifecycle	Authors' definition building on Schrader (1999, 110)
Factors affecting customer acceptance (drivers, barriers)	Factors are elements that either affect circular customer acceptance positively, making them drivers, or negatively, making them barriers, or both Drivers are factors that affect customer acceptance positively Barriers are factors that affect customer acceptance negatively	Authors' definition building on (Govindan and Hasanagic 2018; Schrader 1999; Tunn, Fokker, et al. 2019)
Practices enabling customer acceptance	Practices are methods a company can deploy to foster customer acceptance for a product or service by altering the customer perception of circular factors, either by enhancing the positive effect of drivers, alleviating the negative impact of barriers, or both	Authors' definition building on (Gaur et al. 2021; Mugge et al. 2017; OED Online 2024)

factors that lie outside the individual that make the behaviour possible or prompt it" (please see definitions for sources of behaviour in Appendix B). Further, it suggests nine intervention functions to elicit behavioural change (please see definitions in Appendix B). The wheel also includes policy categories that can enable these interventions, which are outside the scope of this paper as it focuses on micro-level interactions between companies in the circular economy and their customers. While the behaviour change wheel was primarily applied in the health and medicine field, it is now increasingly applied in the context of sustainability (Allison et al. 2022). It was specifically chosen as the theoretical underpinning of this work, as it is designed to identify changeable target behaviours and inform respective interventions (Allison et al. 2022). Further, it was selected for its applicability to circular business models, which require behavioural change in relation to reducing, reusing, and recycling, as shown in previous empirical works (Allison, Ambrose-Dempster, et al. 2021; Allison, Lorencatto, et al. 2021; Gainforth et al. 2016) In addition, the framework is also used outside of academia, by policymakers, think tanks, NGOs, and companies. For example, the European Commission's European Circular Economy Stakeholder Platform (2022) uses it to discuss behavioural change. The framework is applied as a conceptual model for changing consumer behaviours in relation to reducing resource input and fostering more sustainable laundry habits in a collaboration between Procter and Gamble, the World Wide Fund for Nature (WWF), and the Collaborating Centre on Sustainable Consumption and Production (CSCP) (Strube 2023). Given the framework's applicability in the context of this study and its increasing diffusion as a conceptual underpinning, we build on the behaviour change wheel to understand customer behaviour in the circular economy and to identify interventions to facilitate behaviour change.

2.3 | Digital Technologies as an Enabler of Circular Business Models

Digital technologies can be seen "as combinations of information, computing, communication, and connectivity technologies" (Bharadwaj et al. 2013). These technologies, such as the internet of things, big data analytics, artificial intelligence, and blockchain technologies, have seen increased proliferation over the recent years, especially during COVID-19, and are seen as key enablers of innovation (Nambisan et al. 2017; Ting et al. 2020). In fact, digital technologies, specifically related to the Industry 4.0 (Nascimento et al. 2018), have been identified as critical enablers of circular business model innovation (Ranta et al. 2021). In this study, we build on a structure of digital technology layers, from the product to the service interface, as seen in Table 2.

While a growing number of studies have investigated the use of digital technologies in the circular economy, only a few first studies have explored the role of digital technologies in fostering customer acceptance of circular business models (Alonso-Muñoz et al. 2021). Casado-Vara et al. (2018) discuss the use of blockchain technology across the supply chain to ensure data reliability and enhance the customer's trust in the product's origin. Esmaeilian et al. (2020) discuss the use of blockchain and tokenisation to promote circular customer behaviour, such as buying products or services in exchange for crypto tokens. Charnley et al. (2022) discuss the use of digital tools to address convenience and trust issues that customers have in the second-hand fashion market. Table 3 provides an overview of such studies. Assessing these studies shows a focus on literature reviews as the dominant methodological approach. Most of these studies investigate digital technologies individually and not in combination, and customer acceptance is usually addressed as a side topic.

TABLE 2 | Digital technology layers adapted from Guo et al. (2020).

Digital technology layer	Definition
Service layer	Describes the customer's use of services provided by organisational players before, during and after the use of a respective offer
Cognition layer	Describes the information and knowledge gain achieved through deriving insights from data gathered along the entire supply chain
Interaction layer	Describes the communication and collaboration between customers, products and organisational players before, during, or after the purchase
Perception layer	Describes the intelligent apprehension and connection of circular products and capabilities
Product layer	Describes the production capabilities of an industrial player regarding the design, equipment selection, and manufacturing process

Our review of the literature in the field reveals themes across the studies' findings, limitations, and suggestions for future research. Most studies make claims about the enabling role of digital technologies for the circular economy, some explicitly referring to their function in helping companies meet customer needs.

Common limitations across the studies include the lack of customer behaviour as a central focus, discussions limited to single technologies, and business models. The most common limitation as pointed out by Ranta et al. (2021, 1) is that "extant research on the implementation of digital technologies and related business model innovations for establishing circular economy within firms remains conceptual and lacks empirical evidence".

These studies focus heavily on literature reviews (Gebhardt et al. 2021; Toth-Peter et al. 2023). Agrawal et al. (2022, 2023), Agrawal, Wankhede, Kumar, Luthra, et al. (2021), and Agrawal, Wankhede, Kumar, Upadhyay, et al. (2021) alone offer four literature reviews from three consecutive years on the topic, each urging for more empirical work, such as case studies, that examine the practical application of digital technologies.

TABLE 3 | Studies evaluating the role of digital technologies for customer acceptance of circular business models.

Source	Method	Digital technologies	Customer focus[a]	Findings	Limitations	Gaps/key needs suggested for future research
Agrawal, Wankhede, Kumar, Upadhyay, et al. (2021)	Literature review	Multiple (e.g., internet of things, data analytics, 3D printing)	—	Digital technologies enabling the circular economy (e.g., education and participation); customer involvement necessary	No explicit focus on the customer; no explicit examples of use cases	Frameworks to conceptualise CE and digitalisation to overcome barriers; emphasise role of customers (e.g., in reverse logistics)
Agrawal et al. (2023)	Literature review	Multiple (e.g., artificial intelligence, machine learning, big data, internet of things)	—	Customer acceptance is a barrier; technology can help to understand customer needs; customer management can result in loyalty and satisfaction; SC collaboration as key driver	Based on mostly conceptual work; the study assumes a very high-level view	Need for more empirical work; need for firm-level evaluation
Bigerna et al. (2021)	Survey	Single (i.e., blockchain)	x	Customers have a higher willingness to pay for durable or repairable consumer electronics when certified (e.g., by blockchain)	Survey focuses on the stated intention to purchase, prone to intention-behaviour gap; investigation of a single technology; investigate two factors (durability, reparability)	Explore different countries; identify barriers for the use of digital technologies
Bressanelli et al. (2018)	Literature review, single case study	Multiple (i.e., internet of things, big data, analytics)	—	Applications of digital technologies to address CE barriers (i.e., product usage data to target and market customers better and adapt product design; enhance personalisation; users' willingness to pay)	Single case study as empirical basis; limited number of digital technologies investigated; limited focus on customer behaviour	Extend empirical sample with additional qualitative data; investigate broader spectrum of digital technologies; include other business model types (than PaaS)
Casado-Vara et al. (2018)	Conceptual (i.e., (software model)	Single (i.e., blockchain)	—	Blockchain enabled supply chain traceability and transparency would enhance customer trust	Conceptual work; focused on single digital technology; limited focus on customer behaviour; conference paper	Include perspective of more agents

(Continues)

TABLE 3 | (Continued)

Source	Method	Digital technologies	Customer focus[a]	Findings	Limitations	Gaps/key needs suggested for future research
Charnley et al. (2022)	Literature review, survey, interviews	Multiple (e.g., chatbot, algorithms, internet of things)	x	Barriers of customer acceptance; enabling role of digital technologies to overcome these barriers by exploiting related opportunities	Journal quality[b]; single business model and industry (i.e., second hand fashion); limited factors of customer needs (i.e., 4); vague definition of "digital tools"; limited empirical support	n/a
Esmaeilian et al. (2020)	Literature review	Blockchain	—	Digital technologies as enabler (i.e., promoting green behaviour through tokenisation)	Literature based; single digital technology focus	Explore case studies and best practices; empirical research on customer perception of (different) digital technologies and practical implementation thereof (e.g., customer use data)
Huynh (2021)	Multiple case study	Multiple (e.g., blockchain, internet of things, QR codes)	—	Digital technologies as the enabler (e.g., predictability of customer behaviour); customer acceptance considered to be a critical challenge	Limited empirical data base; single non-EU country focus	Focus on the customer's role in digital fashion; explore development of digital technology use cases
Khatami et al. (2023)	Receiver operation characteristic analysis	Not specified (i.e., digital ecosystems)	—	Consumer behaviour contributes to plastic waste; digital technologies can reduce plastic waste	Limited concrete practical insights and qualitative understanding provided	Concrete qualitative explanation how consumer behaviour and digital technologies can reduce waste production
Lopes de Sousa Jabbour et al. (2023)	Survey	Automation, sensors, simulation, big data analytics, digital services	x	Digital technologies and customer integration as key enablers to implement the circular economy	Limited to one country (i.e., Brazil); no concrete understanding of digital technologies	Identify further variables; utilise qualitative methods
Planing (2017)	Literature review	Not specified	—	Digital technologies as enablers of the circular economy; customer behaviour (i.e., acceptance) defined as key prerequisite	No empirical base; limited literature review; no concrete examples	Develop better understanding of customer behaviour (i.e., in-depth analysis of acceptance)

(Continues)

TABLE 3 | (Continued)

Source	Method	Digital technologies	Customer focus[a]	Findings	Limitations	Gaps/key needs suggested for future research
Ranta et al. (2021)	Multiple case study	Multiple (e.g., artificial intelligence, cloud, internet of things)	—	Digital technologies as enablers of the circular economy (e.g., knowledge about customers to identify opportunities)	Limited empirical data base; limited insights regarding customer behaviour; focus on B2B context	Research on consumer-facing business models; customer acceptance for circular business models as a key concern
Saidani (2022)	Interviews	Multiple (e.g., internet of things, sensors, big data, analytics)	x	Limited research on the customer perception of digital technologies	Data collected in the B2B sector; no concrete example of digital technology use cases and B2C customer appraisal thereof	Need to consider circular economy and digital technologies from a B2C customer perspective
Tunn et al. (2020)	Survey, interviews	Multiple (e.g., sensors, smartphones)	x	Digital technologies as enabler of circular business model; significance of factors of customer needs (e.g., convenience, flexibility, control, trust)	Focus on AB-PaaS business models; single industry focus; focus on user, not company perspective	n/a

[a]An (x) signifies a paper's central focus on customer behaviour; a (—) signifies a peripheral examination of the topic.
[b]Journal is suggested to adopt predatory practices.

Future studies could take a consumer-centric approach to exploring the effectiveness of circular economy business models (Ranta et al. 2021; Tunn, Bocken, et al. 2019; Bocken and Konietzko 2022). Researchers could also further examine the role of digital technologies in overcoming barriers to achieving circular economy objectives (Agrawal, Wankhede, Kumar, Upadhyay, et al. 2021). This could include more studies that demonstrate practical mechanisms by which digital technologies enable companies to meet customer needs. Lastly, researchers have been urged to move beyond the investigation of single variables and instead explore the dynamics of multiple digital technologies, business models, and geographical regions across different industries.

These findings highlight the role of the circular economy, customer behaviour, and digital technologies. Yet, their interrelationships as potential avenues for enabling circular economy business models remain underexplored, reconfirming the research gap and supporting the research question, as posed in Section 1.

3 | Methodology

The literature on the study's topic is fragmented and leaves considerable research gaps, such as a more empirical consideration of the topic, a deeper qualitative understanding, and practical examples (Agrawal et al. 2023; Khatami et al. 2023; Lopes de Sousa Jabbour et al. 2023; Ranta et al. 2021). As such, this research employs an exploratory approach (Saunders et al. 2006), generating new insights into this emerging research stream. As recommended for this research approach and for exploring an emerging and under-investigated field, we conducted qualitative semi-structured problem-centred expert interviews with representatives from companies with circular economy business models, management consulting firms, and academia (Döringer 2021; Witzel 2000; Saunders et al. 2006; Littig 2008). Analyzing expert insights is an established approach, especially in technology forecasting (Wang et al. 2019), for understanding complex dynamics, subtleties, and multiple levels of analysis (see Nath and Eweje 2021), as required for this research. We aim to provide a comprehensive overview of factors, practices, and digital technologies that enable customer acceptance. We, therefore, chose to interview experts from different backgrounds. This allows for a broader exploratory investigation of this field compared to other methods, such as a case study approach, that are useful for pursuing a more in-depth inquiry of management phenomena in specific companies (Döringer 2021; Saunders et al. 2006; Witzel 2000).

3.1 | Data Collection

We chose expert respondents for their knowledge of the causal relationships in a system, their well-founded evaluation of the state of affairs on the topic, their anticipatory sensemaking, and their ability to identify necessary actions (Rudolph et al. 2009; Wang et al. 2019). We chose to interview a diverse group of experts to capture a variety of viewpoints, explore developing patterns, and generate collective insights (Wang et al. 2019). To generate such a rich and diverse data set, we sought experts with different backgrounds with respect to industry, circular business models, firm sizes, and roles in companies in the circular economy, management consultancies, and academia (Fabbe-Costes et al. 2014; Hofmann and zu Knyphausen-Aufseß 2022; Huber et al. 2020). We included experts with consulting backgrounds for their overarching knowledge of the field, their ability to identify patterns indirectly contribute to market developments, and triangulate phenomena (see Hofmann and zu Knyphausen-Aufseß 2022). Additionally, we included researchers with practical subject expertise, as done by Tunn, Bocken, et al. (2019) and suggested by an expert on digital technologies (i37), who commented that knowledge of digital technologies as an enabler of the circular economy is currently more advanced and institutionalized in academia than in industry.

Experts from academia and consultants commented on their experience from their work with multiple companies in the circular economy, while company representatives referred to experiences from the companies, they worked in themselves. Researchers were questioned about their empirical observations regarding concrete factors affecting customer acceptance, practices they experienced or employed themselves to enable customer acceptance, and digital technologies used to enable these processes. Examples of this include an electronics producer that designs modular phones, tablets, and laptops, among others, using "barcodes" or "QR codes" on products allowing their customers to order spare parts,[1] addressing customer acceptance factors, such as "product or service availability", reducing "psychological effort", and enhancing "information availability" (i1). Further examples include the use of "RFID" chips to automate the return of reusable coffee cups[2] (i22), the use of "artificial intelligence" to evaluate and pay out directly the value of a returned used product based on indicated product parameters[3] (i20), "blockchain" to trace a used product's history and circular interventions[4] (i13), and "customer journey analytics", such as the use of A/B testing allowing a furniture refurbishing start-up to measure how practices impact their customers' behaviour (i2). More detailed accounts of the observed factors, practices, and digital technologies can be found in Sections 4.1–4.3, respectively. More detailed examples describing the interplay of digital technologies supporting companies' use of practices to address their customer's factors of customer acceptance are shown in Appendix C. We selected the experts based on four criteria, as suggested by Soundararajan and Brown (2016): their level of involvement and relevance to the research context (i.e., circular business models); their level of awareness related to aspects in the research context (i.e., customer behaviour, digital technologies, and circular business model innovation); practical accessibility; and their willingness to take part in the research. We developed a semi-structured interview guide that consisted of five sections, each containing multiple research questions, as exemplified here: (1) an introduction to the topic (e.g., a summary of the research project and context), (2) background information of the expert (e.g., "What are your role and responsibilities within your organisation?"), (3) customer behaviour in the circular economy

(e.g., "What are drivers and barriers of customer acceptance for circular business models?"), (4) digital technologies (e.g., "Which digital technologies does your organisation/do organisations you have worked with, use to involve customers in the context of the circular economy?"), and (5) other (e.g., "Do you have any documents to share that would substantiate your organisation's engagement in this field?"). These questions were often followed by "how?", "what?", and "why?" questions to gain more detailed contextual insights (Saunders et al. 2006). The questionnaire was further refined and narrowed to focus on emerging patterns. The complete interview guide is included in the Appendix A. The interviews were conducted in English or German (based on the preference of each respondent), via Zoom. All respondents were either native speakers or had a professional command of the language in which the interview was conducted. Interview durations were between 30 and 90 min. All interviews were transcribed verbatim using Trint in the respective languages to avoid compromising data quality. The transcripts were coded thematically using Nvivo 12 Pro. To substantiate and triangulate the interview data, we collected additional secondary data in the form of white papers, academic articles, press interviews, corporate websites, and other sources that were either identified by our research team or suggested/shared by the experts (see Hofmann and zu Knyphausen-Aufseß 2022). Data collection stopped once theoretical saturation was reached after conducting 41 interviews (Saunders et al. 2006). An overview of the conducted interviews can be found in Table 4.

3.2 | Data Analysis

The data analysis was conducted in a multiple-step iterative process (Elgeti and Kleinaltenkamp 2022; Glover et al. 2014; Wang et al. 2019). This involved drawing on concepts identified in the literature (Section 2) and developing concepts from the interview data (Huber et al. 2020; Miles and Huberman 1994; Saunders et al. 2006).

We developed first-order-categories for factors affecting customer acceptance, enabling practices, and digital technologies (Gioia et al. 2013). We then developed second-order themes by considering similarities and differences between these codes (Elgeti and Kleinaltenkamp 2022) (Figures 1–3). The second-order themes for digital technologies were then compared and matched with the five layers of digital technologies from the literature to form aggregate dimensions (Elgeti and Kleinaltenkamp 2022; Guo et al. 2020) (see Figure 3). First-order categories of factors and practices were linked to the behaviour change wheel dimensions (i.e., "sources of behaviour" and "intervention functions", Michie et al. 2011) to demonstrate the existing framework's applicability to this study (see Tables 6 and 8). The behaviour change wheel was suggested to be used for this study by a professor for behavioural economics, when the authors discussed a concept for a related paper. While the behavioural change wheel has not yet been broadly discussed in the emerging circular economy literature, it is a widely accepted concept in behavioural science and was therefore integrated in this study to build on existing literature, accepted terminology, and utilised as an analytical lens. As the behavioural change wheel was not integrated in the data collection, the authors developed the thematic structures in Figures 1–3 independently and unbiased. This allowed the authors to analyse the results and assess the behavioural change wheel's fit as an explanatory concept for the observed phenomenon.

Further, enabling practices were linked to factors affecting customer acceptance to assess how customer behaviour can be influenced by interventions from companies, as done by Bressanelli et al. (2019) and suggested by the European Environment Agency (2019) (see Table 9). The identified digital technologies were matched with the intersections between factors and practices to identify examples of digital technologies supporting these processes (Table 11). More detailed examples of the interrelatedness between factors, practices, and digital technologies are presented in the form of two use cases in Appendix C. Lastly, we propose an aggregated account of the findings in the form of an extended behaviour change wheel (Figure 4) based on Michie et al. (2011) and suggest four propositions for further research.

We employed several techniques to enhance data reliability and validity to overcome the challenges of generalising findings from qualitative studies (Creswell 2009). To ensure reliability, two researchers developed first-order concepts independently. These codes were aggregated into second-order themes, which were cross-checked by another coder. To ensure a common understanding, 120 first-order concepts, second-order themes, and aggregate dimensions were compiled and individually defined in an open coding effort (Saunders et al. 2006). To ensure intercoder agreement, one of the co-authors iteratively cross-checked the linking of codes. In a "discursive alignment of interpretation" (Seuring and Gold 2012, 547; Pagell et al. 2010; Nath and Eweje 2021), the researchers eventually achieved intercoder agreements for linking factors to sources of behaviour (85% 1st round, 93% 2nd round), linking practices to intervention functions (86% 1st round, 89% 2nd round), and linking factors with practices (86% 1st round, 95% 2nd round) in an axial coding effort (Saunders et al. 2006). Hence, the coding satisfies the recommended consistency of 80% to ensure good qualitative reliability (Miles and Huberman 1994).

To ensure validity, we used a data triangulation approach which involved examining secondary data sources, such as company websites. We presented findings, such as matching factors, practices, and digital technologies, to selected experts to ensure accurate representation. Peer briefing with senior researchers within the study team was used to scrutinise the procedure and elicit suggestions. Additionally, we used senior researchers outside the study team as external auditors to assess the study's findings. While this study's findings show a fair representation of the collected data, the results are not definitive. That is, the identified factors, practices, and digital technologies are not exhaustive and could be extended by further research. Further, the findings are not mutually exclusive, as factors, practices, and digital technologies can be categorised differently, depending on the context in which they operate.

TABLE 4 | Overview of interviews.

ID	Role(s) and expertise	Organisation	Country of organisation	Years of relevant experience	Interview duration (min)
1	CTO	(Circular) Electronics producer	Germany	3	95
2	CEO & Co-Founder	Furniture Refurbisher	Germany	9	70
3	CEO; Researcher	Design Agency; Research Institute	Sweden	13	60
4	Chairman of the Board; Partner and CEO	Circular Construction Materials; Sustainability Advisory and Investment Company	Denmark	5	75
5	Co-Founder	Producer of Sustainable Tissue Products	UK	6	30
6	Co-Founder	Reusable Packaging Solution Provider	Germany	3	55
7	CEO & Co-Founder	Circular Design Agency	France	6	30
8	Country Head of Circular Economy	Producer of (Circular) Sports Equipment and Services	Netherlands	1	50
9	Director for Customer Service & Quality	Producer of (Circular) White Goods	Germany	10	85
10	Director of Product, Planning & Strategy/Business Development	Micro-Mobility aaS Provider	Germany	2.5	60
11	Founder	Platform for Refurbished Products	Austria	6	40
12	CEO & Founder	Furniture aaS Start-up	Austria	3	45
13	Global Business Developer	(Circular) Furniture Retailer	Sweden	10	75
14	Global Head of Circular Economy	Producer of Circular Plastics	Germany	5	65
15	Global Head of Innovation	Producer of Circular Cleaning Products	Belgium	16	50
16	Head of Circular Economy	(Circular) Construction Equipment Company	Switzerland	7	45
17	Head of Circular economy	Platform for Refurbished Products	Germany	2	60
18	Head of Product Development	Platform for Refurbished Products	Finland	3	80
19	Head of Sustainability; Founder; PhD researcher CE Innovation	Consumer Electronics aaS Start-up; CE Professional Network/Think Tank	Germany/Switzerland	6	90
20	Head of Sustainability; Researcher & Lecturer Circular and Sustainable Innovation	Fintech CE Start-up; Academia	UK/Netherlands	6.5	60
21	Managing Director	Furniture aaS Start-up	UK	26	55
22	Managing Director, Co-Founder	Climate Tech Venture Capital Firm	Germany/Switzerland	6	45

(Continues)

TABLE 4 | (Continued)

ID	Role(s) and expertise	Organisation	Country of organisation	Years of relevant experience	Interview duration (min)
23	Non-Executive Director, Corporate Advisor and Investor	Producer of Sustainable Tissue Products; Producer of Natural Food	UK	8	75
24	Product Manager	Producer of Circular Fashion	Sweden	7	55
25	Senior Consultant; Advisor	Circular Footwear Producer; Sustainable Consumption and Production Think Tank	Germany	19	90
26	Senior Product Manager; PhD Sustainable Consumption	Sustainable IT Start-up	Germany	15	30
27	Specialist for Innovation & Business Strategy	Producer of (Circular) Sports Articles	Switzerland	1.5	70
28	Supply chain manager	Producer of (Circular) Home Textiles	Finland	2	50
29	Sustainability Director	Producer of (Circular) Parental Equipment	Netherlands	4	60
30	Associate (CE in Construction and Mobility)	Sustainability Think Tank/Consultancy	Germany	3	75
31	Associate Partner (CE & Sustainability, Consumer Goods)	Management Consultancy	Germany	17	60
32	Director (Circular Business Models)	Sustainability Think Tank/Consultancy	Germany	3	60
33	Partner (Sustainability, Circular Economy)	Management Consultancy	Germany	10	60
34	Partner (Sustainability, Circular Economy)	Management Consultancy	Sweden	1.5	40
35	Partner (Sustainability, Consumer Goods)	Management Consultancy	Germany	12	45
36	Product Design Expert	Management Consultancy	USA	9	30
37	Project Manager (Digital Technologies)	Management Consultancy	Germany	4	60
38	Senior Expert (Circular/Sustainable Product Development)	Management Consultancy	Germany	13	45
39	Assistant Professor Circular Economy	Academia	Netherlands	5.5	60
40	Professor for Sustainable Production & Consumption	Research Institute	Germany	30	65
41	Research Associate Industrial Sustainability	Academia	UK	17	30

4 | Results

4.1 | Factors Affecting Customer Acceptance

This section highlights companies' understanding of their customers as a prerequisite of customer acceptance. Yet, multiple experts indicate that "many companies have little insight into their customers" (i19) and run the risk of "innovating past their customer needs" (i26). It was noted that a company is required to have insights into the diverse range of factors that influence customer acceptance (i31). Figure 1 shows a thematic structure of all the results, identified through the interviews, that classifies these 35 factors into eight categories. Table 5 highlights exemplary quotes from these interviews, categorised into first-order concepts and second-order themes.

The factors were classified into first-order concepts and second-order themes, which were developed inductively, based on the meanings of these factors as indicated by the respondents. For example, "habit" describes a customer's settled disposition or tendency to act in a certain way. If a circular business model requires the customer to behave differently or in line with their previous behavioural patterns, this factor can be perceived as inconvenient or convenient. In the context of "customer's skill" a circular business model may require the customer to exchange a component or repair a product, requiring a different set of "knowledge"

Each factor can be a driver of customer acceptance, a barrier to it, or both.Price, for example, is usually identified as a barrier since circular products are often more expensive than linear products. However, competitive prices can also be a driver (i33). Hence, the applicability of these factors, influence, and importance are diverse. They depend on the sector, product, customer age, customer income, social setting, and other contextual factors (i39, i40).

Contrary to expectation, "sustainability" is not among the top influential factors. Several experts identified the preceding importance of other factors, such as "price", "quality", and "convenience" (i5, i29, i30, and i35). While customers perceive environmental sustainability positively, most value it only as a bonus (i29 and i33), and only a niche market assesses it as a key factor (i31 and i33). Instead, circular business models must be able to compete on core acceptance factors with linear products to be scalable (i25, i33). Simply put, "everybody likes sustainability, but sustainability alone does not sell" (i33). This is a key learning, as "currently, circular business models focus too much on their customers' willingness to behave pro-environmentally. Yet, this will only attract early adopters. To convince the rest and achieve scale, organisations will have to develop a compelling value proposition" (i33). Individual factors carry different importance, while some constitute make-or-break criteria.

In the next step, we linked the identified factors affecting customer acceptance with appropriate sources of behaviour from the behaviour change wheel, as introduced in Section 2.2 and further described in Section 3.2 (Michie et al. 2011). For example, "physical effort", related to the customer's perception of the convenience of a circular business model, is generally associated as a barrier to customer acceptance (i33 and i39). However, these factors may be related to different sources of behaviour depending on the individual customer. In the case of a subscription-based circular business model that requires the customer to return products to a local post office or other logistics provider, this factor of customer acceptance may be perceived differently. One customer may have impaired mobility, impeding their "physical capability". Another customer may realise that the partnering logistics provider is situated far away as part of their analytical decision making, which may elicit negative feelings as a form of "reflective motivation". Yet another customer may have already formed a negative disposition towards walking to this logistics provider based on previous experience, leading to an immediate emotional response as a form of "automatic motivation". These examples show the applicability of the behaviour change wheel and highlight the importance of contextualization, as factors can address customers' sources of behaviour differently (see Table 6).

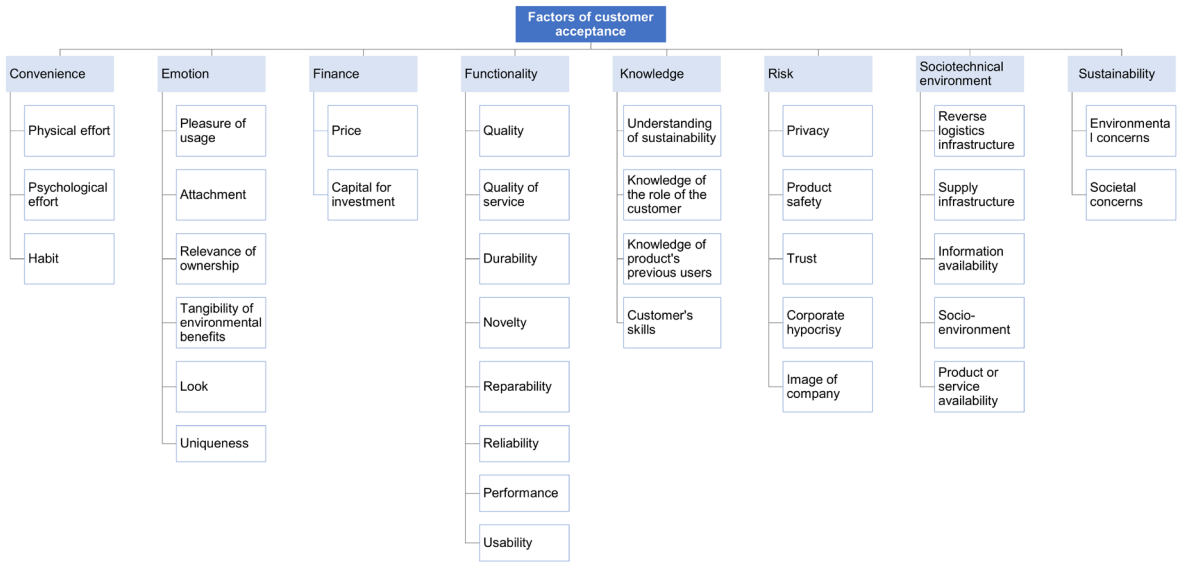

FIGURE 1 | Thematic structure of factors affecting customer acceptance. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 5 | Exemplary quotes in relation to factors affecting customer acceptance.

Illustrative second-order theme	Illustrative first-order concept	Exemplary quote	Respondent
Convenience	Habit	"I think probably routines and habits are the barrier inhibiting that change a bit. ... So, I think people have so much to do in their daily lives that they try to minimise, of course, the effort put into such decisions. ... if you've routinised that you go to certain websites or shops for certain products, if you then have a circular business model that is maybe a totally different website environment or shop, then that might just be a bit less accessible because of that, because it requires an additional thought and, and additional step to actually go there and look for options"	i39
Emotion	Ownership	"But I think also for our consumers, the biggest driver is that it's more accepted and that it's the younger generation that is now buying our products. So, it's more normal in society now to lease stuff instead of owning it. And I think that's the biggest shift. Our product was ready for leasing already ten years ago. It was also durable back then. It just wasn't really accepted... We do make a very durable product, like I say, but it's also an emotional product"	i29
Emotion	Tangibility of environmental benefits	"They really like the story behind that because it's very visible and tangible. ... The minute you put a recycled, let's say, kitchen chopping boards in some black plastic bags, it looks like a beautiful marble surface. You put that on a table that starts the conversation and it's a real credential around sustainability. So, ... in order to sort of sex up the office furniture industry, we've included a lot of waste products, waste recycled waste products in our furniture to actually improve the sustainability and create some really outstanding products"	i21
Risk	Privacy	"...the problem we get to is the creepiness and the privacy concerns. I think when people are tracked to that level of detail with something that's especially when it comes to simpler products, then, you know, there's a lot of push back ..."	i33
Risk	Product safety	"Safety, safety is very important. Many people naturally want to arrive safely, or everyone wants to arrive safely. If the vehicle is somehow rickety, the turn signal doesn't work, and the brakes are broken, that is of course not acceptable"	i10

Overall, the experts' responses highlight the diverse nature of customer behaviours (see Table 6). This data shows that most factors relate to customers' "motivation" followed by "opportunity" while very few factors relate to their "capability" To our knowledge, this thematic structure (Figure 1) represents the most comprehensive empirical overview of factors affecting customer acceptance in relation to circular business models.

4.2 | Practices Enabling Customer Acceptance

Compared to the organisations' knowledge of factors influencing customer behaviour, organisations lag behind in developing and implementing practices that address the identified factors (i3 and i40). We identified a total of 36 practices that companies use to foster customer acceptance for their circular business models, which were classified into eight categories (see Figure 2). Exemplary quotes that were categorised into illustrative first-order concepts and second-order themes are shown in Table 7.

Linking the identified practices with the appropriate intervention functions, part of the behaviour change wheel (Michie et al. 2011), shows that organisations focus more on certain functions than on others (see Table 8). For example, gamifying circular behaviours, which can be achieved through applications on mobile devices, may reinforce circular behaviours, such as product return, and enhance the acceptance of such business models (i10, i15, i19, and i22). These practices relate to multiple intervention functions. Including monetary or virtual incentives can lead to an expectation of reward for the customer, that is, "incentivisation". Alternatively, constructing a gamification model in which customers can compete with one another and compare achievements would provide an example for people to imitate or aspire to meet the standards set by others (i.e., "modelling") (Michie et al. 2011).

Next, we matched the factors affecting customer acceptance with appropriate practices. This follows Michie et al.'s (2011) logic in the behaviour change wheel (i.e., "intervention

TABLE 6 | Thematic structure of factors affecting customer acceptance linked with sources of behaviour from behaviour change wheel.

Factors of customer acceptance		Behaviour change wheel: sources of behaviour					
		Capability		Motivation		Opportunity	
2nd order theme	1st order category	Physical	Psychological	Reflective	Automatic	Physical	Social
Convenience	Physical effort	X		X	X		
	Psychological effort			X	X		
	Habit				X		X
Emotion	Pleasure of usage				X		
	Attachment				X		
	Relevance of ownership			X	X		X
	Tangibility of environmental benefits		X				
	Look				X		
	Uniqueness			X			
Finance	Price			X			
	Affordability	X					
Functionality	Quality			X	X	X	
	Quality of service			X	X	X	
	Durability					X	
	Novelty			X			X
	Reparability					X	
	Reliability					X	
	Performance					X	
	Usability					X	
Knowledge	Understanding of sustainability		X				
	Knowledge of the role of the customer		X				
	Knowledge of product's previous users		X				
	Customer's skills	X	X				
Risk	Privacy			X			
	Corporate hypocrisy			X			
	Product safety			X	X	X	
	Trust			X			
	Image of company			X			X

(Continues)

TABLE 6 | (Continued)

Factors of customer acceptance		Behaviour change wheel: sources of behaviour						
		Capability		Motivation		Opportunity		
2nd order theme	1st order category	Physical	Psychological	Reflective	Automatic	Physical	Social	
Sociotechnical environment	Reverse logistics infrastructure	X				X		
	Socioenvironment						X	
	Supply infrastructure					X		
	Information availability		X			X		
	Product or service availability					X		
Sustainability	Environmental concerns			X			X	
	Societal concerns			X			X	
Total		4	6	15	10	12	7	54

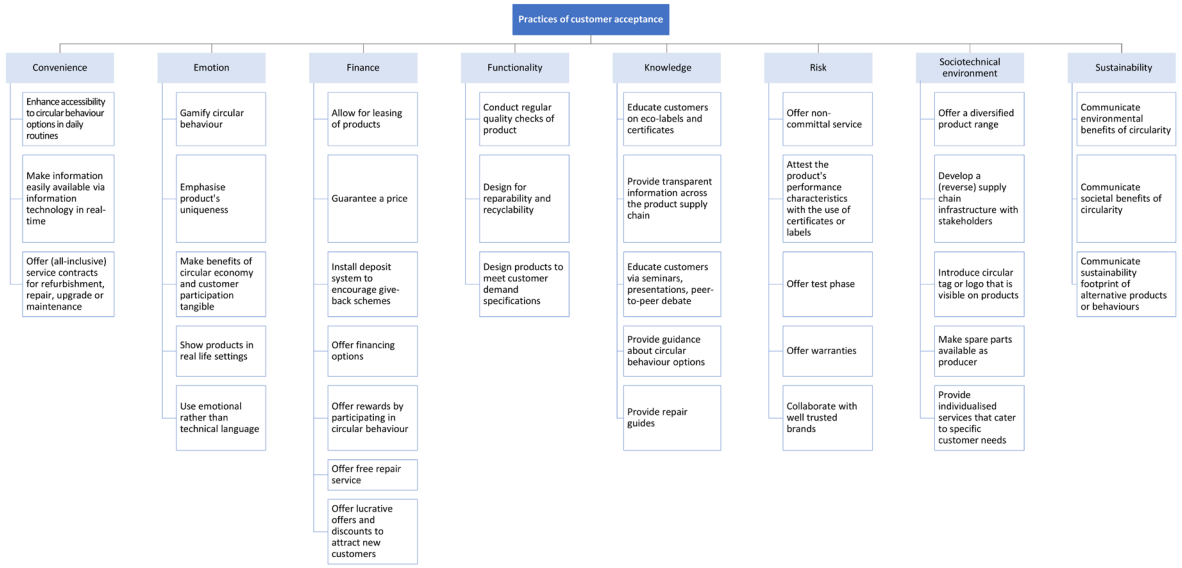

FIGURE 2 | Thematic structure of practices enabling customer acceptance. [Colour figure can be viewed at wileyonlinelibrary.com]

functions" addressing "sources of behaviour") and a similar approach pursued by Bressanelli et al. (2019). Contrary to Bressanelli et al.'s (2019) work that focuses on barriers that need to be overcome, we also include factors constituting drivers of acceptance that can be further strengthened. As seen in Table 7, one practice can impact multiple factors, depending on the context. "Enhancing accessibility to circular behaviour options in daily routines", for example, affects eight factors, such as all three factors relating to "convenience", (i.e., "physical effort", "psychological effort", and "habit"). Circular business models, in which spare parts are delivered directly to the customer's door, can reduce the customer's perception of "physical effort" (i20). Another circular business model delivers a return shipping label directly with the product itself, which reduces the customer's "psychological effort" to identify the correct shipping address (i27). Yet another circular business model sets up drop boxes in shops, which are part of the customers' regular routines, which act as a driver of acceptance (i13).

These thematic structures show that companies have developed most practices catered towards the "enablement", "education", "environmental restructuring", and "persuasion" of their customers. At the same time, little to no efforts are made towards

TABLE 7 | Exemplary quotes in relation to practices that enable customer acceptance.

Illustrative second-order theme	Illustrative first-order concept	Exemplary quote	Respondent
Finance	Allow for leasing of products	"... the machines are technologically exactly the same. ... The added value of the technology is not necessarily at the machine level, but rather at the level of networking with the customer. ... we're shifting from "I sell drills" to a fleet operator. The advantage for the customer is that ... I don't have to buy entire machines and I can react flexibly to peaks ... I need twice as many machines next week and then I can have them and buy this flexibility to a certain extent"	i32
Finance	Offer rewards by participating in circular behaviour	"The players in the electronics sector are also doing this, but now also in the fashion sector, the take-back programs, where customers then have the opportunity to resell used products, so to speak, to retailers or manufacturers and this often works today via marketplaces that then enable the customer to get the best price for their products, so to speak"	i31
Knowledge	Educate customers via seminars, presentations, peer-to-peer debate	"We're a new category ...that has the quality of new but the price and the greenhouse gas emissions of, of used. Therefore, we have to explain how the circular economy allows that. So, we spend a lot of time educating about that. ... So, we educate them about that and some consumers ... really love that because they're getting into the nitty gritty. And what we're able to do is tell them something they've never heard before..."	i21
Risk	Collaborate with well trusted brands	"Several of the recycling players are trying to build a brand around their fibre, so [company] are branding their fibre [fibre brand name] ... But [brand name] is still also targeting the brands. So going to H&M and ... trying to get them to say okay we want [brand name]'s materials in our clothes and then they pull it through the value chain and they go to the brands and say, look, we have a fibre which is called [brand name], and we even have a tag that you can add to your garments with information around it. So, they try to make it simple for brands to bring out the added sustainability value from the [fibre brand name] fibre. And they want to you know, the dream is to build a brand similar to Gore-Tex, but for the fibres ... the more mature example of that [company] which are fibre producers that have [fibre brand name], which is fairly famous brand... and they've managed to make it an ingredient brand. So, you know that you buy a [fibre brand name] dress or sweater"	i34
Sociotechnical environment	Make spare parts available as producer	"You get modular products that are already designed so that you can upgrade at the end. [Company] in Holland, for example, you can then buy your new cell phone camera and get a manual on how to take it apart"	i20

"incentivisation", "modelling", "coercion", "training", and "restriction", showing that not all intervention functions of the behaviour change wheel are equally utilised.

A matrix linking factors and practices can be seen in Table 9. Based on the 35 factors and 36 practices identified in the interviews, the matching illustrates 260 examples of how organisations can employ practices to address their customers' acceptance factors. Some examples are more obvious, such as to "offer warranties" in case if customers have "quality" concerns (i33, i35). However, it also contains less apparent examples, such as to "show products in real-life settings" to overcome "quality" concerns (e.g., a furniture refurbishing company offers customers the option to visit former client locations to convince themselves of the quality of refurbished products (i21)). The thematic structure introduced in this chapter (Figure 2) shows one of the first and the most comprehensive overview of practices that companies can employ to enable customer acceptance.

4.3 | Digital Technologies

The data set showcases differing expert responses regarding the importance of digital technologies and their level of implementation. While some experts stated that, currently, digital

TABLE 8 | Thematic structure of practices that enable customer acceptance linked with intervention functions from behaviour change wheel.

Practices		COM-B model of behaviour: Intervention functions								
2nd order theme	**1st order category**	**Education**	**Persuasion**	**Incentivisation**	**Coercion**	**Training**	**Restriction**	**Environmental Restructuring**	**Modelling**	**Enablement**
Convenience	Enhance accessibility to circular behaviour options in daily routines									X
	Make information easily available via information technology in real-time									X
	Offer (all-inclusive) service contracts for refurbishment, repair, upgrade or maintenance							X		
Emotion	Gamify circular behaviour			X					X	
	Emphasise product's uniqueness	X	X							
	Make benefits of circular economy and customer participation tangible	X								
	Show products in real life settings								X	X
	Speak to the customer's emotions		X							

(Continues)

TABLE 8 | (Continued)

Practices		COM-B model of behaviour: Intervention functions								
2nd order theme	**1st order category**	**Education**	**Persuasion**	**Incentivisation**	**Coercion**	**Training**	**Restriction**	**Environmental Restructuring**	**Modelling**	**Enablement**
Finance	Allow for leasing of products							X		
	Guarantee a price							X		
	Instal deposit system to encourage give-back schemes				X					
	Offer financing options							X		
	Offer rewards by participating in circular behaviour			X						
	Offer free repair service							X		
	Offer lucrative offers and discounts to attract new customers			X						
Functionality	Conduct regular quality checks of product									X
	Design for reparability and recyclability									X
	Design products to meet customer demand specifications									X

(Continues)

TABLE 8 | (Continued)

Practices		COM-B model of behaviour: Intervention functions								
2nd order theme	**1st order category**	**Education**	**Persuasion**	**Incentivisation**	**Coercion**	**Training**	**Restriction**	**Environmental Restructuring**	**Modelling**	**Enablement**
Knowledge	Educate customers on eco-labels and certificates	X								
	Educate customers via seminars, presentations, peer-to-peer debate	X								
	Provide guidance about circular behaviour options	X								
	Provide repair guides					X				
	Provide transparent information across the product supply chain	X	X							
Risk	Attest the product's performance characteristics with the use of certificates or labels		X							
	Collaborate with well trusted brands		X							
	Offer non-committal service							X		
	Offer test phase							X		
	Offer warranties		X					X		

(Continues)

TABLE 8 | (Continued)

Practices		COM-B model of behaviour: Intervention functions									
2nd order theme	**1st order category**	**Education**	**Persuasion**	**Incentivisation**	**Coercion**	**Training**	**Restriction**	**Environmental Restructuring**	**Modelling**	**Enablement**	
Sociotechnical environment	Develop a (reverse) supply chain infrastructure with stakeholders									X	
	Introduce circular tag or logo that is visible on products	X							X	X	
	Make spare parts available as producer									X	
	Offer a diversified product range									X	
	Provide individualised services that cater to specific customer needs									X	
Sustainability	Communicate environmental benefits of circularity	X									
	Communicate societal benefits of circularity	X	X								
	Communicate sustainability footprint of alternative products or behaviours	X									
Total		10	7	3	1	1	0	8	3	11	44

TABLE 9 | Thematic structure of factors linked with practices that enable customer acceptance.

		Factors																																							
Practices		Physical effort	Psychological effort	Habit	Pleasure of usage	Attachment	Tangibility of environmental benefits	Look	Uniqueness	Relevance of ownership	Price	Affordability	Quality	Quality of service	Durability	Novelty	Reparability	Reliability	Performance	Usability	Understanding of sustainability	Knowledge of the role of the customer	Knowledge of product's previous users	Customer's skills	Privacy	Corporate hypocrisy	Product safety	Trust	Image of company	Reverse logistics infrastructure	Socioenvironment	Supply infrastructure	Information availability	Product or service availability	Environmental concerns	Societal concerns	Total
2nd order scheme	1st order concept	Convenience			Emotion						Finance		Functionality								Knowledge				Risk					Sociotechnical environment					Sustainability			
Convenience	Enhance accessibility to circular behaviour options in daily routines	X	X	X													X	X											X		X		X			8
	Make information easily available via information technology in real-time		X											X						X	X	X					X					X				7
	Offer (all-inclusive) service contracts for refurbishment, repair, upgrade or maintenance	X	X											X	X		X	X	X				X			X	X				X					11
Emotion	Gamify circular behaviour		X	X	X		X																							X						5
	Emphasise product's uniqueness					X		X	X							X																					4
	Make benefits of circular economy and customer participation tangible						X																			X											2
	Show products in real life settings		X					X					X		X			X	X								X	X					X				9
	Speak to the customer's emotions					X			X																			X	X									4
Finance	Offer financing options		X							X		X		X																								4
	Offer rewards by participating in circular behaviour										X			X																								2
	Guarantee a price										X																	X										2
	Allow for leasing of products											X		X																			X					3
	Install deposit system to encourage give-back schemes																												X									1
	Offer free repair service		X			X			X		X			X	X		X	X	X								X	X	X		X	X			X		15
	Offer lucrative offers and discounts to attract new customers										X	X																										2
Functionality	Design for reparability and recyclability	X	X			X										X	X	X	X										X					X			9
	Conduct regular quality checks of product												X	X	X			X	X										X									6
	Design products to meet customer demand specifications							X																							X				X			3
Knowledge	Provide transparent information across the product supply chain		X				X																X			X	X	X	X				X		X	X	10
	Educate customers on eco-labels and certificates		X																		X					X		X					X		X		6
	Educate customers via seminars, presentations, peer-to-peer debate		X				X			X											X	X		X		X	X	X	X		X		X		X	X	14
	Provide guidance about circular behaviour options		X				X			X											X	X							X		X		X		X	X	10
	Provide repair guides	X	X		X	X	X		X					X	X		X	X	X			X		X			X				X	X		X	X		18
Risk	Offer warranties										X		X	X	X			X	X								X										7
	Attest the product's performance characteristics with the use of certificates or labels		X															X	X		X				X	X	X	X	X				X		X	X	12
	Offer test phase		X											X				X	X									X									5
	Offer non-committal service		X								X	X		X				X	X									X									7
	Collaborate with well trusted brands		X						X				X		X	X		X	X							X	X	X	X		X		X		X		14
Sociotechnical environment	Offer a diversified product range			X																												X		X				3
	Develop a (reverse) supply chain infrastructure with stakeholders	X	X	X			X																					X	X	X				X			8
	Introduce circular tag or logo that is visible on products		X				X	X	X																			X		X							6
	Make spare parts available as producer		X			X									X		X	X	X					X		X	X		X		X	X		X	X		14
	Provide individualised services that cater to specific customer needs	X	X						X					X															X									5
Sustainability	Communicate societal benefits of circularity		X				X														X					X			X		X		X			X	8
	Communicate environmental benefits of circularity		X				X														X					X			X		X		X		X		8
	Communicate sustainability footprint of alternative products or behaviours		X				X														X	X				X					X		X		X		8
Total		6	24	4	2	6	11	4	7	3	6	4	4	12	8	3	5	13	13	0	8	5	2	4	1	10	9	15	15	2	13	7	11	5	13	5	260

technologies had little to no relevance for their circular business models (e.g., i21), most experts agreed on the importance of technology as an enabler of the circular economy. One expert stated that "digital technologies are incredibly important for the circular economy, especially to implement solutions really efficiently" (i12). However, some experts specified that companies often only pilot digital technologies and, in some cases, are far from implementing such solutions (i2, i13, i19, and i37). Another expert remarked that digital technologies have not yet seen wide adoption in industry and often only exist on a conceptual level (i37). Yet, multiple experts provided examples of real-life use cases of digital technologies from the production layer to the service layer, with all results shown in Figure 3. Exemplary quotes, that are categorised into illustrative first-order concepts and second-order themes, are shown in Table 10. The results show that some of those technologies can be used in combination, such as "QR codes" and "mobile technologies" (i27), and others interchangeably, such as "QR codes" or "RFID" chips (i38). Overlying technologies describe more generic technology clusters, such as the "internet of things", made up of more specific technologies, such as "RFID".

When transferring the empirical findings from this study to the behaviour change wheel (Michie et al. 2011), this research highlights the wide range of opportunities for organisations to use digital technologies in enabling change in behaviour, that is, customer acceptance of circular business model innovation. A more detailed overview can be found in Table 11. It shows the different digital technologies (i.e., technological enablers) that can be used to facilitate practices (i.e., intervention functions) for influencing factors that affect customer acceptance (i.e., sources of behaviour), further highlighting the fit to the behaviour change wheel. The numbers in the cells are the results of multiplying the number of intervention functions that a digital technology addresses with the number of sources of behaviour that can be addressed through these intervention functions. The purpose of this exercise is to provide an indication of the versatility of the respective digital technologies in promoting customer acceptance in this context. In particular, "mobile technologies" can be widely used to provide information and services from other technologies, such as "chatbots" or "internet of things", in the form of websites or applications. Given that companies weigh the cost of using digital technologies against their impact (i2, i37), current examples show the application of more low cost technologies compared to advanced technologies or resource-intensive technologies, such as "blockchain" or "3D printing" (i13 and i22).

The data further shows many use cases for selected intervention functions of the behaviour change wheel (Michie et al. 2011),

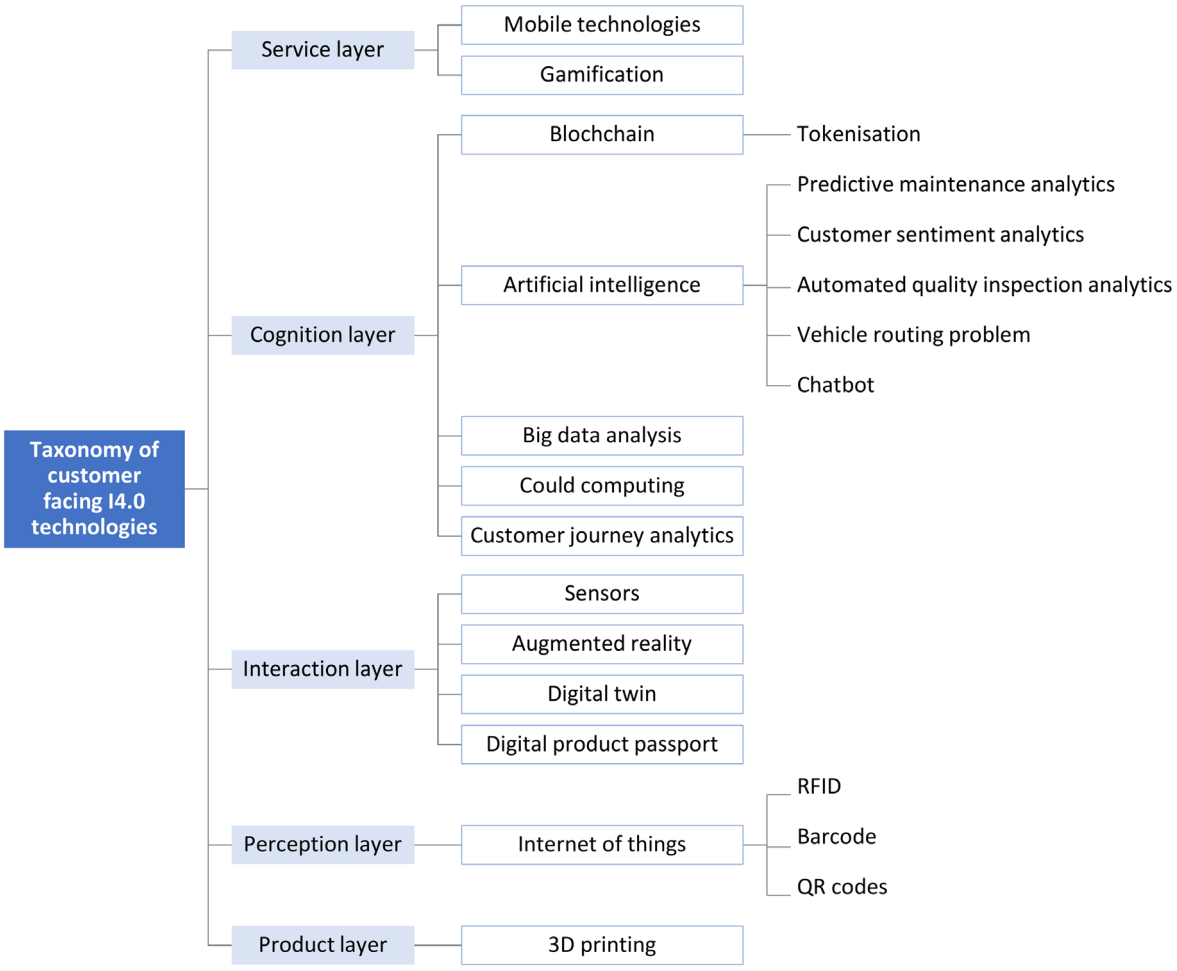

FIGURE 3 | Thematic structure of digital technologies facilitating practices for enabling customer acceptance. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 10 | Exemplary quotes in relation to digital technologies.

Illustrative second-order theme	Illustrative first-order concept	Exemplary quote	Respondent
Service layer	Gamification	"So, the intention was from the beginning very clearly to give the consumer feedback on their consumption and try to steer that as well. So, encourage people to wash at lower temperatures by doing so. They did a lot of different experiments with gamifying it, comparing it with that and benchmarking it with ... other people with similar households. ... Just showing you also over the months how it changes and maybe like if you would wash at this temperature, it would mean this in terms of energy consumption or have you considered using the eco mode?"	i39
Interaction layer	Blockchain	"[Company] is a London start-up that does this, [company] is a blockchain start-up from the USA that really wants to make it traceable right through to the customer: where do the products come from, who had them, what ethics, what environmental impact have somehow been incorporated into the value chain, even though ten different players were involved"	i20
Interaction layer	Digital twin	"But if I really want to have robust CE solutions, I just need to know where stuff is at. And I don't typically know where stuff is at or who has it or what its condition is. So, the idea of a digital twin that follows something throughout its life, being able to understand ... where they land is something much more complex ..."	i33
Perception layer	RFID (internet of things)	"...this is de facto a company that tries to solve disposable coffee cups at the airport... They [customers] don't have time, they carry it [coffee cup] to the gate and then they throw it away. What they did, within this closed cycle of the airport, they basically ... produced coffee cups that have RFID chips in them. People simply buy their coffee, pay €1 extra for this cup and then there are garbage collection points all over the airport as you know them. But there is also a waste collection point for these coffee cups. And when you've finished your drink at the gate, you can throw your coffee cup in there. It will be credited to your credit card"	i30
Perception layer	QR codes (internet of things)	"And of course, at the moment we already make use of QR codes. I think on our newest models we might already have a QR code on the frame .... So, if you scan it, you get like a user guide ..."	i29

while others are less pronounced or not shown in the data sample. Companies appear to mostly use digital technologies that can lead to the "enablement" of their customers, either by increasing means or reducing barriers, for example, providing information conveniently via "barcodes" or "QR codes" that customers can scan. Other common intervention functions include "training", "environmental restructuring", "education", and "persuasion". The data shows fewer or no examples for the use of digital technologies related to "incentivisation", "coercion", "restriction", or "modelling". Through these intervention functions, digital technologies have the most potential to address customer "motivation" as a source of behaviour, create "opportunity" for different behaviours, and influence the customer's "capability" to behave differently.

This data set represents the first comprehensive overview of digital technologies that companies can employ to support intervention functions targeted to influence their customers' sources of behaviour, thus enabling customer acceptance of their circular business models. This supports the applicability of the behaviour change wheel concept in this research domain and suggests adding the technological dimension as an additional layer. To highlight the practical relevance of these results, we have selected use cases as examples and described them in the Appendix.

5 | Discussion

The following sections will discuss the study's findings on factors, practices, and digital technologies to propose an extended framework of the behaviour change wheel (Section 5.1), assess the framework's validity in light of different circular business model types and supply chain collaboration contexts (Section 5.2), and discuss the study's contribution to theory and practice (Section 5.3).

5.1 | The Behaviour Change Wheel Extended by a Technology Dimension

This study's results highlight the need for companies with circular business models to have the ability to understand

TABLE 11 | Use cases for digital technologies within the behaviour change wheel (heatmap depending on frequency). [Colour table can be viewed at wileyonlinelibrary.com]

	Capability									Motivation											Opportunity										
	Physical				Psychological					Reflective						Automatic						Physical						Social				
Digital technology	Education	Training	Envir. restruct.	Enablement	Education	Persuasion	Training	Envir. restruct.	Enablement	Education	Persuasion	Incentivisation	Training	Envir. restruct.	Enablement	Education	Persuasion	Incentivisation	Training	Envir. restruct.	Enablement	Education	Persuasion	Incentivisation	Training	Envir. restruct.	Enablement	Education	Persuasion	Training	Envir. restruct.	Enablement
1 Service layer																															
1.1 Gamification				2	1					1		2		8	2			1		4	3			1		7	5			3	1
1.2 Mobile technologies	12	28	11	3	158	34	42	1	24	21	198		84	92	111	74	58		84	54	88	53	18		112	78	138	146	8	28	21	6
2 Cognition layer																															
2.1 Blockchain				4	1	6			2	1	24				6		6				6		12				2		9		8
2.1.1 Tokenisation				4	1	4			2	1	16				6		4				6		8				2		6		8
2.2 Artificial intelligence															12						9						21				1
2.2.1 Predictive maint. anal.			6	2				3						15	13					12	8					21	11				6
2.2.2 Customer sent. anal.																					2						2				2
2.2.3 Autom. qual. insp. anal.				1											8						5						8				3
2.2.4 Vehicle routing problem				4					4						7						8						12				2
2.2.5 Chatbot		18		9	16		27		15	2			54		32	8			54		25	4			72		41	2		18		23
2.3 Big data analytics			8	4	1			3		1				21	12					18	1					23	12				2	8
2.4 Could computing			6	1	1			3	1	1				15	4					12	3					21	7					3
2.5 Customer journey anal.									4						3						3						3					1
2.6 Process automation				2											1						7						7					7
3 Interaction layer																																
3.1 Sensors			6	4	1			3		1				15	12					12	9					21	11					7
3.2 Digital Twin			8	1	2			4	9	2				2	24					16	2					28	16					22
3.3 Digital product passport			1	6	2	2		5	1	2	17			25	31		5			2	21		4			35	26		6			16
4 Perception layer																																
4.1 Internet of things		4		17			6		26		9		12		49		3		12		42				16		51		3	4		28
4.1.1 RFID	1			12	5				21	8					33	3					29	2					35	5				2
4.1.2 Barcode	1			12	5				22	8					34	3					29	2					31	5				23
4.1.3 QR codes	1			12	5				22	8					34	3					29	2					31	5				23
5 Product layer																																
5.1 3D printing				1					1						4						3						7					3

changing customer acceptance factors and the capacity to react to these factors by utilizing appropriate practices and technologies.

In line with the ongoing focus on factors affecting customer acceptance in the literature (Islam et al. 2021; Rexfelt and Hiort 2009), this study's findings emphasise the importance for companies in the circular economy to develop an understanding of their customers' behaviors (i19, i31, and i22). The companies participating in this study use various techniques to understand their customers, including calls, emails, focus groups, small-scale interviews, large-scale surveys, and sentiment analyses (i25, i37, and i36). They recognize the varying importance of factors in general, over time and during the buying process. One expert (i11) stated that sustainability is more important at the beginning of the buying process while assessing the general image of a company and after the purchase when evaluating the consumption decision with a good conscience. During the purchasing phase, however, factors such as price, customer ratings, services, and speed of delivery are more important in the decision-making process.

Companies have a relatively limited understanding of the different practices at their disposal to address these factors. Some have identified the use of various practices as effective tools for innovating their circular business models to address their customers' acceptance factors and use them deliberately (i2, i10, i16, and i27). However, a majority of the experts have observed that their industry sectors have yet to make significant progress, focusing on piloting and, in some cases, only planning to implement targeted measures in the future (i5, i4, i12, i13, and i14).

Several experts in this study confirmed the importance of digital technologies in facilitating customer-oriented innovation (i10, i12, i19, and i20). While implementations of such technologies were especially noted in start-ups, traditional organisations are slower to adapt to these novel technologies, sometimes only piloting them or contemplating potential use cases (i12, i37, and i13). A large furniture manufacturer (i13) considers 3D printing to be an option to offer customers decentralised and prompt repair services for broken furniture. However, the expert from this company was of the opinion that implementing such an idea would take another decade due to the lack of prescribed management responsibilities for disruptive technology-based innovation for their circular offerings.

We propose an extended version of the behaviour change wheel by Michie et al. (2011) that recognizes the role of digital technologies, building on five layers of technology enablers (see Guo et al. 2020). Thereby, we tie largely isolated research streams together and highlight their interrelationships in a comprehensive framework based on three interlinking elements: (1) sources of behaviour (i.e., factors), (2) intervention functions (i.e., practices), and (3) technological enablers (i.e., digital technologies) (Figure 4; see use cases detailed in sections Appendix C). Compared to the original behaviour change wheel, which includes a policy dimension, the extended behaviour change wheel bears higher operationality for companies, focusing on the enabling use of technologies. This conceptual framework allows companies to reflect on their circular business models in light of their customers' behaviour and make technology-supported modifications as necessary in relation to their specific value proposition, creation and delivery, and capture.

While the extended framework possesses broad validity, we recognize its varying applicability depending on the types of circular business models the focal company operates and the forms in which it collaborates with its supply chain stakeholders. Hence, based on expert inputs, the following section assesses the framework's applicability for different circular business model types (Section 5.2.1) and different forms of supply chain collaboration (Section 5.2.2).

5.2 | Assessment of Applicability for the Extended Behaviour Change Wheel

5.2.1 | Influence of Circular Business Model Types on the Applicability of the Framework

The data shows the varying potential of digital technologies to enable customer acceptance depending on the type of circular business model. This is reflected in the expert responses, attaching "extreme importance" (i12) or "absolutely zero" (i21) importance to digital technologies. This section will discuss such differences and propose a categorization of four types of circular business models.

One expert pointed out the importance of digital technologies for short-term access services, compared to long-term services, as the customer has a higher interaction frequency with the organization or product (i12). E-scooter rentals offer an example. Every time users rent a scooter, they revert to digital technologies to locate, unlock, and return it. Since the rental periods are short, the frequency of transactions between customer and company is high (e.g., daily). So, the digital technologies form a make-or-break criterion for the business model (i10). This suggests the importance of digital technologies for business models with high transaction frequency, as supported by the findings of Tunn et al.'s (2020, 6), Belk (2014), and Tunn et al. (2021). This leads us to the following proposition.

Proposition 1. *Digital technologies bear higher relevance for circular business models that operate at high frequency of customer-company touchpoints.*[5]

The margin per transaction is another variable determining the applicability of digital technologies. Implementing digital technologies comes at a cost that must be matched against its benefits (i2, i12). Transactions with a high margin may support the cost of implementing and operating digital technologies. For example, washing machines (with rental periods lasting several months) operate at high transaction margins. However, the technologies used to capture and communicate the machines' usage data, such as sensors, IoT, and cloud computing, do not constitute make-or-break criteria and are subject to a cost–benefit analysis (i39).

On the other hand, circular business models operating at low transaction margins may not support such technologies unless

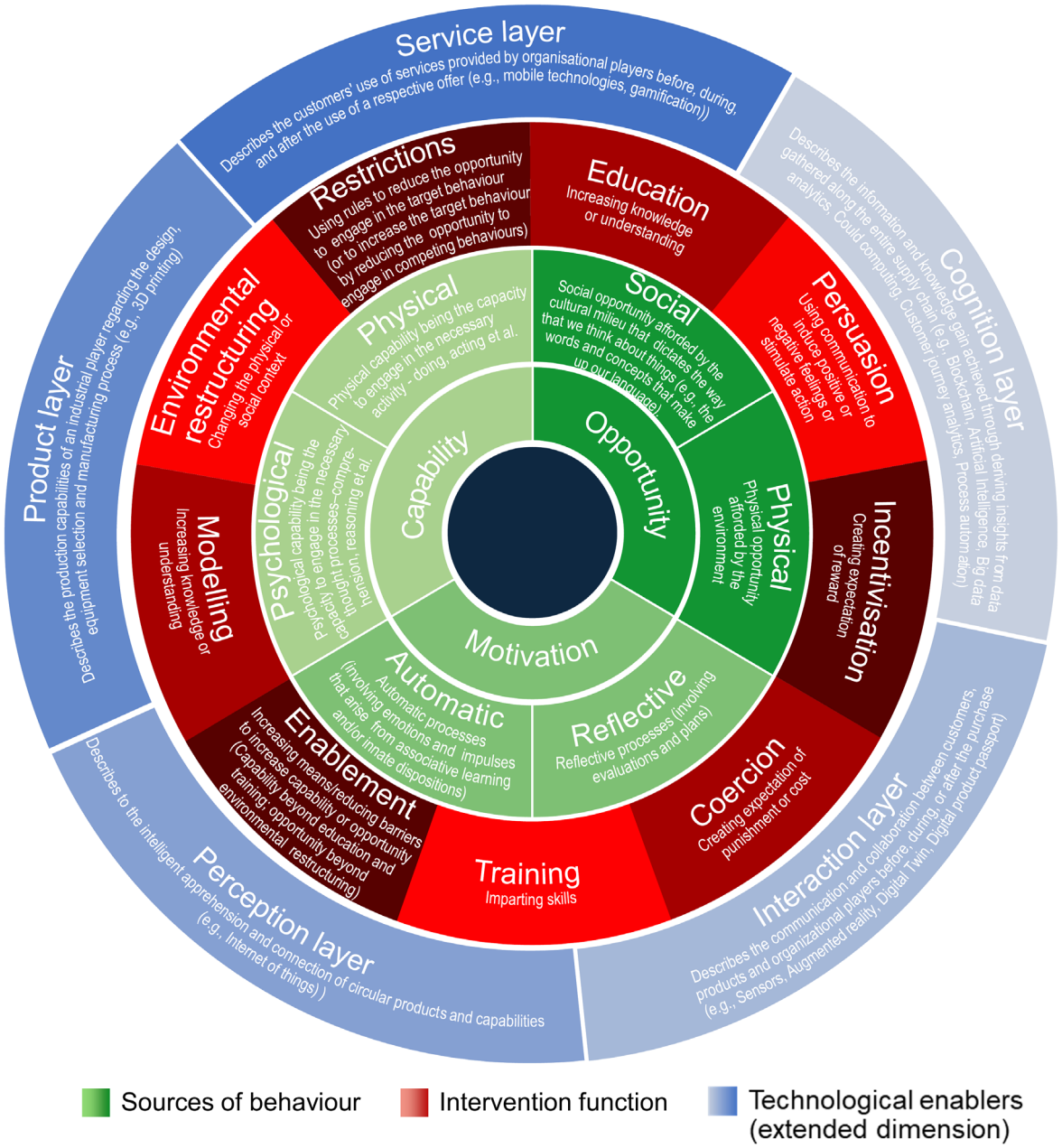

FIGURE 4 | Behaviour change wheel by Michie et al. (2011) extended by a technology dimension. [Colour figure can be viewed at wileyonlinelibrary.com]

there are large volumes of transactions that produce economies of scale. Here, low-cost technologies generally take priority over cost-intensive, often hardware-based technologies, such as sensors, as a form of frugal innovation. In light of the decreasing cost of operating such technologies (Sabbatini et al. 2023), a trend towards increased proliferation can be assumed in the future. This leads us to the following proposition.

Proposition 2. *Digital technologies have a greater viability for circular business models that operate at high margins per transaction.*

As a result, our findings suggest differing levels of viability for digital technologies used to facilitate customer acceptance. We propose a hierarchical sequence of viability for circular business models, in which (1) high-frequency touchpoints and high-margin transactions take priority ("no-brainer"), followed by (2) high-frequency touchpoints and low-margin transactions that depend on economies of scale ("numbers game") and for which digital technologies may constitute make-or-break criteria, (3) low-frequency touchpoints and high-margin transactions that depend on cost–benefit analyses ("cost–benefit") and for which digital technologies do not constitute make-or-break criteria, and lastly (4) low-frequency touchpoints and low-margin transactions that depend on the growing affordability of technology ("late bloomer") (Table 9). This leads us to the following proposition.

Proposition 3. *The viability of digital technologies for facilitating customer acceptance of circular business models follows*

a hierarchical sequence with a preference for high-frequency touchpoints, high-margin transactions, and low-cost technology over low-frequency touchpoints, low-margin transactions, and high-cost technology. This proposition is displayed in Figure 5.

5.2.2 | Influence of Different Supply Chain Collaboration Forms on the Applicability of the Framework

As our findings suggest, a solitary company that aims to enhance customer acceptance falls short. While consumer-facing companies in the circular economy are seen as the most powerful stakeholders in achieving customer acceptance (i22), experts in this study emphasize their dependence on other supply chain stakeholders (i3, i7, and i13), especially when facing the complexities of implementing digital technologies. Building on Barratt (2004), this section will consider five forms of supply chain collaboration to achieve customer acceptance for circular business models.

Internal Collaboration: Customer acceptance is not achieved by one department adopting a silo perspective (i25). It is an interdisciplinary task that requires an interplay of all key functions, including procurement, research and development, design, operations, logistics, marketing and sales, finance, data science, IT, and sustainability (i20, i25, i29, i37, and i39).

Internal collaboration differs between incumbents and start-ups. Start-ups in this study show high degree of agility with small cross-functional teams working together to quickly identify prototype and pilot solutions, such as digital technologies, and to innovate their circular business models (i3, i11, i20, i25, and i36). However, start-ups often lack the financial resources to invest in costly technologies, especially when not externally funded, restricting their adoption potential and limiting them to affordable technologies (i1, i2, i12, and i22). On the other hand, experts noted incumbents' lack of speed, difficulty in achieving collaboration between business units, and struggle to find responsible decision-makers to drive innovation initiatives, such as the adoption of digital technologies (i3, i13, i14, and i31). Hence, a collaboration between incumbents and start-ups seems mutually beneficial, as supported by Veleva and Bodkin (2018) (see "external collaboration (competitors)").

External Collaboration (Suppliers): Companies in the circular economy depend on their suppliers. Supplier interaction can be a hurdle for customer acceptance when suppliers fail to meet quality requirements (i2) or refuse to share supply chain information required for blockchain technology implementation (i13 and i22). Collaboration with suppliers can also enhance customer acceptance. For example, textile manufacturers using sustainable fibres, Lyocell and Circulose, strengthen customer trust through ingredient branding (i34).

External Collaboration (Customers): Customers can also become contributors. Experts highlighted a range of different options to involve customers in the innovation process, including focus groups, pilots, lead user tests, interviews, quantitative and qualitative surveys, co-creation, feedback loops, and (click-through) prototypes (i3, i4, i16, i20, i23, i25, i26, i29, i36, i38, i40, and i50).

External Collaboration (Competitors): As discussed before and suggested by Veleva and Bodkin (2018), collaborations between incumbents and start-ups can be beneficial. For example, Bundles, a Dutch start-up offering washing machines-as-a-service, developed a mutually beneficial partnership with Miele, the manufacturer (Bundles 2023). While Miele supplies Bundles exclusively, allowing Bundles to profit from economies of scale, Bundles shares the machines' usage data with Miele for product development purposes, allowing for economies of scope.

External Collaboration (Other Organisations): Given the challenges associated with implementing digital technologies, companies revert to service providers specialising in such technology solutions. Unown Fashion, for example, has extended its offering from operating a circular fashion e-commerce platform to offering a white-label software and operations solution that supports other brands in building their fashion platforms (Unown 2023). The solution's functions include continuously tracking items via RFID technology, shipping, returning, and refurbishing. This hints at the development of ecosystems in which individual players offer specialised services to increase effectiveness and efficiency. Collaborators can also include NGOs, research institutions, and policymakers (i2, i13, i23, i35, and i37).

The above discussion leads us to the following proposition.

Proposition 4. *Implementing digital technologies for the purpose of attaining customer acceptance for circular business models is contingent upon extensive collaboration, surpassing the level observed in the linear economy. This collaboration encompasses both internal collaboration among various business units within*

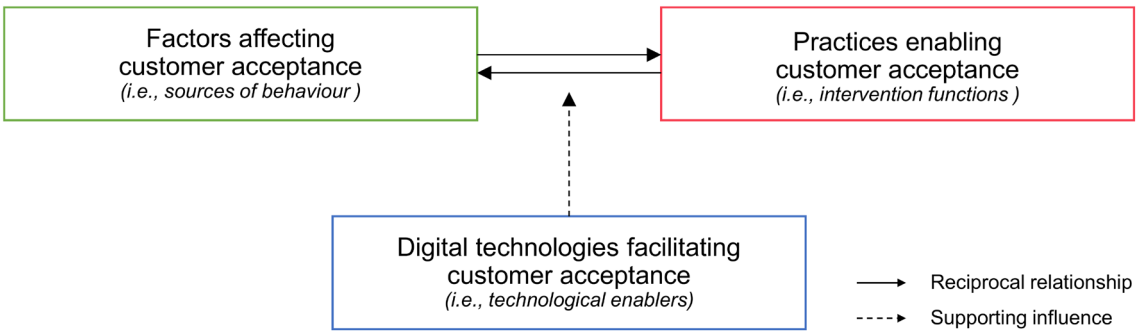

FIGURE 5 | Viability of digital technologies for facilitating customer acceptance for different circular business model types. [Colour figure can be viewed at wileyonlinelibrary.com]

a company, as well as external collaboration with stakeholders, such as customers, competitors, suppliers, and other organisations. Ultimately, this collaborative effort leads to the establishment of interconnected ecosystems.

The novelty and complexity of this phenomenon surpass the capabilities of most individual actors, thereby intensifying the need for collaboration (Mousavi et al. 2019). Previous studies have provided evidence supporting the importance of collaboration and co-creation in the circular economy, which involves the utilisation of interdisciplinary teams and the engagement of customers and other strategic stakeholders (Khan et al. 2020; Mousavi et al. 2019; Santa-Maria et al. 2022). Our findings indicate that collaboration holds particular significance for companies seeking to implement and leverage the enabling capacity of emerging and disruptive digital technologies.

With these findings, we go beyond the scope of previous studies in this field, which undertake high-level conceptual explorations of the role of digital technologies in the context of circular economy business models (Gebhardt et al. 2021; Ranta et al. 2021; Toth-Peter et al. 2023). Our findings highlight the spectrum of viability of digital technologies for circular business models in this context, ranging from high to insignificant. In addition, we propose variables that influence viability, namely, the value and frequency of touchpoints and technology costs, and propose a hierarchical order of viability. Last, we propose that the implementation of digital technologies is influenced by the ecosystem surrounding the focal firm.

5.3 | Contribution to Theory and Practice

This study builds on findings of earlier studies, addresses their limitations, and follows their suggestions for future research (Table 3). As suggested by the literature, it takes an empirical approach (Agrawal, Wankhede, Kumar, Upadhyay, et al. 2021; Bressanelli et al. 2018; Casado-Vara et al. 2018; Esmaeilian et al. 2020) that provides practical qualitative firm-level understanding (Agrawal et al. 2023; Bressanelli et al. 2018; Khatami et al. 2023) in different B2C markets (Bigerna et al. 2021; Ranta et al. 2021; Saidani 2022), puts the customer at the center of its focus (Agrawal, Wankhede, Kumar, Upadhyay, et al. 2021; Esmaeilian et al. 2020; Huynh 2021; Planing 2017; Ranta et al. 2021; Saidani 2022), presents concrete use cases for different digital technologies, used individually and jointly (Agrawal, Wankhede, Kumar, Upadhyay, et al. 2021; Bigerna et al. 2021; Bressanelli et al. 2018; Casado-Vara et al. 2018; Esmaeilian et al. 2020), and conceptualises these insights in a framework (Agrawal et al. 2023; Agrawal, Wankhede, Kumar, Luthra, et al. 2021).

5.3.1 | Theoretical Implications

This study provides three main contributions to theory:

1. It provides comprehensive thematic structures for factors, practices, and digital technologies. This includes one of the largest empirically based thematic structures consisting of 35 factors affecting customer acceptance (see Figure 1), attesting to the diversity of sources of customer behaviors. This shows that most factors affecting acceptance are related to the "motivation" of customers, followed by their "opportunity", while the least factors relate to their "capability". It provides the most comprehensive thematic structure for 36 practices impacting customer behavior in the literature (see Figure 2). It moves the current discussion from a passive perspective, focusing on acceptance factors, to an active perspective, focused on practices companies that can deploy to influence their customers' behaviors. Further, it shows that most practices cater toward the "enablement", "education", "environmental restructuring", and "persuasion" of their customers. At the same time, little or no efforts are made toward "incentivisation", "modelling", "coercion", "training", and "restriction". Lastly, this study provides the first comprehensive thematic structure for digital technologies that enhance customer acceptance (see Figure 3). Thereby, it builds on and extends findings relating to digital technologies as enablers for meeting customer needs, as discussed in previous studies (Bigerna et al. 2021; Bressanelli et al. 2018; Charnley et al. 2022), providing practical qualitative examples, as called for and lacking in prior research (Bressanelli et al. 2018; Esmaeilian et al. 2020; Khatami et al. 2023; Saidani 2022).
2. This study is one of the first to assume a comprehensive empirical perspective on the connection between different digital technologies and their enabling role in the circular economy. Its main contribution is to tie largely isolated research streams, focusing on the circular economy, digital technologies, and customer behaviour, and highlight their interrelationships in a comprehensive framework, addressing the need for relevant theory development (Agrawal, Wankhede, Kumar, Upadhyay, et al. 2021). This allows us to investigate customer acceptance in the circular economy through an integrative perspective encompassing sources of behaviour, intervention functions, and technological enablers (see Figure 6). The extended behaviour change wheel (Figure 4) focuses on the potential of technological enablers rather than the policy categories included in the original framework, and is, therefore, better suited to guiding companies in overcoming current economic challenges and accelerating the transition to the circular economy (Agrawal, Wankhede, Kumar, Upadhyay, et al. 2021; Bigerna et al. 2021). Thereby, this study introduces and develops the behavioural change wheel as an appropriate analytical lens for customer behaviour in the circular economy context that future researchers can utilize. While this framework can be used in different contexts, we recognize that our empirical data does not confirm its application across all intervention functions.
3. Lastly, we assess the viability of digital technologies for enabling the circular economy through customer acceptance and, thus, the applicability of the proposed framework. By discussing the influence of the frequency of touchpoints between the company and the customer and the margin per transaction, we suggest a hierarchical sequence of viability for different circular business model types (see Figure 5 and the first three propositions). This builds on earlier

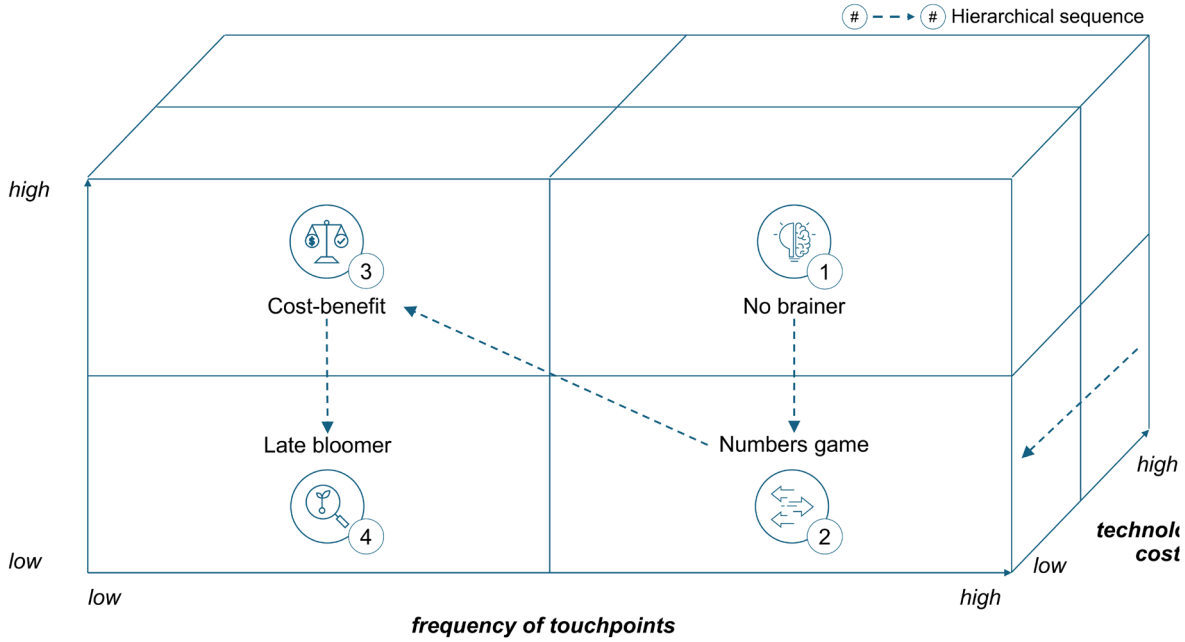

FIGURE 6 | Simplified behaviour change model enabled through technological enablers. Building on the terminology from Michie et al. (2011). [Colour figure can be viewed at wileyonlinelibrary.com]

findings by Belk (2014), Tunn et al. (2021), and Sabbatini et al. (2023). Further, we highlight the importance of supply chain collaboration in circular business model innovation to achieve customer acceptance using digital technologies and describe five collaboration forms (see the fourth proposition). This builds on and confirms earlier findings on the importance of collaboration in the circular economy and for the implementation of digital technologies (Khan et al. 2020; Mousavi et al. 2019; Santa-Maria et al. 2022).

5.3.2 | Managerial Implications

This study generates concrete insights for practitioners in the circular economy, providing the following contributions:

1. The study identifies real-life examples of 35 factors affecting customer acceptance, 36 practices, and digital technologies that practitioners can apply in the context of their circular business models, thus addressing the need to develop an empirically derived body of knowledge in this context (Agrawal et al. 2023; Bressanelli et al. 2018; Esmaeilian et al. 2020; Khatami et al. 2023; Planing 2017). Our data further suggests that the combined use of multiple digital technologies, as exemplified in the use cases (see Appendix C), may contribute to higher-order effects than the use of single technologies, as done in other studies (Bigerna et al. 2021; Casado-Vara et al. 2018; Esmaeilian et al. 2020).
2. The study demonstrates the granular matching of factors, practices enabling customer acceptance, and digital technologies (see Table 11). Concrete examples of use cases (see Appendix C) show the interrelationships between these elements. These examples can be used as guidance on how to transfer the interrelationships to other business contexts. Hence, these sections assist managers in making better decisions (Brax et al. 2021).
3. The study suggests four types of circular business models[6] that lend themselves to using digital technologies as an enabler of customer acceptance. The hierarchical sequence will help companies critically assess the enabling role of digital technologies in their circular business models.
4. Lastly, the study discusses five forms of supply chain collaboration to enhance the effectiveness and efficiency of organisations in implementing digital technologies to achieve customer acceptance, hinting at the importance of ecosystems and open innovation for circular business model innovation. This confirms and extends prior research on the importance of collaboration in this field (Belk 2014; Tunn et al. 2021, 2020).

5.4 | Limitations

This study features the following limitations. It is exploratory and aims to provide an aggregated view on the investigated phenomena. As such, the proposed framework serves a higher-level purpose of providing conceptual clarity and guiding research and practice across industries. Therefore, care should be taken when testing its validity in a concrete use case with idiosyncratic market conditions. While we deem our findings on factors, practices, and digital technologies comprehensive, we do not assume they are exhaustive. While we have tested the meaning and application of factors, practices, and digital technologies with topic experts, we recognize that these elements can carry different meanings depending on the context and are not mutually exclusive. Therefore, this framework is a first major step that requires further refinement and application to different circular business model types, industries, and regions.

This research is limited by its strong focus on companies and their customers, but we recognize the importance of collaboration with all key stakeholders within the ecosystem. While customer behavior lies at the core of this study, no customers were interviewed or surveyed directly, which limits the study's perspective to the interviewed parties' perception of customer behavior. Moreover, this study focuses on the mechanisms that companies can use to foster customer acceptance. However, behaviors causing adverse sustainability outcomes were not addressed.

While this study's findings represent the collected data fairly, the results are not definitive. The identified factors, practices, and digital technologies are not exhaustive and could be extended in future research. Further, the findings are not mutually exclusive, as factors, practices, and digital technologies can be categorized differently, depending on their context.

5.5 | Future Research

Based on expert insights in this study, findings, and limitations, we propose the following topics for future research:

Factors affecting customer acceptance, practices, and digital technologies:

a. We suggest testing their interrelatedness, as described in our framework, in different industries, regional contexts, and circular business model contexts;

b. We suggest future researchers to investigate whether the sources of customer behaviour are evenly pronounced in the circular economy or whether some (i.e., "motivation" and "opportunity") are more pronounced than others (i.e., "capability"), as observed in this study. When investigating this, we suggest differentiating between socio-economic groups, such as the elderly (Tunn et al. 2020);

c. We recommend attempting to replicate our findings regarding practices enabling customer acceptance; specifically, we suggest investigating if any intervention functions[7] are more pronounced than others, as found in this study;

d. Considering the lack of research on multiple digital technologies used jointly, we suggest researchers to explore the use and effect of multiple digital technologies compared to the use of individual digital technologies;

e. While this study suggests that digital technologies are enablers of the circular economy, digital technologies may also inhibit customer acceptance. For example, some customers may lack digital confidence or knowledge (Tunn et al. 2020); hence, we suggest investigating the inhibiting role of digital technologies on customer acceptance;

f. We suggest future studies to measure the effect of using practices of customer behaviour and enabling digital technologies to verify their actual impact;

Extended behaviour change wheel and theory development:

a. We propose testing the framework's applicability in the context of different circular business model types (Propositions 1–3);

b. Considering the significant impact of stakeholder collaboration when achieving customer acceptance (i3, i7, and i13), we call on researchers to investigate the effect of collaboration with individual stakeholders, such as suppliers, software providers, NGOs, research institutions, policymakers, competitors, as well as collaboration within a multi-stakeholder ecosystem (Proposition 4). Such studies should investigate different stakeholder perspectives, including the views of suppliers, service providers, or policymakers (see Toth-Peter et al. 2023), and in ecosystem perspective.

c. While this study regards the customer as the motivator for innovation, we encourage examining the role of the customer as an active contributor as well since customer involvement can often be "rudimentary and there are few examples" (i38);

d. From a theory perspective, we recognize this study's analogy and the proposed framework's fit with the dynamic capabilities theory (Teece 2007), as companies in the circular economy are required to understand their customers' changing behaviors (i.e., sense), react dynamically (i.e., seize), and build capabilities jointly with their stakeholders (i.e., transform); hence, we suggest integrating our framework with the dynamic capabilities perspective (Elf et al. 2022; Khan et al. 2020; Lopes de Sousa Jabbour et al. 2023; Prieto-Sandoval et al. 2019; Sandberg 2023) in future studies;

Method:

a. Since this study aims to provide a comprehensive view of the investigated phenomenon based on expert interviews, we suggest that future studies adopt a multiple case study approach as a suitable method for testing these findings and deriving further insights.

b. Further, we see the need to translate these insights to inform companies' circular business model innovation processes in relation to their value proposition.

c. As this study takes a consumer-facing focus, we propose investigating industry-facing companies as well, considering the unexploited "state of the B2B sector, given the potential there is" (i33);

d. Since our findings revealed significant differences between incumbents and start-ups (i3, i11, i20, i25, i31, and i36), future studies could investigate differences and similarities in their approaches to collaboration with other stakeholders, innovation management, and financial management.

e. To complement this qualitative research using expert interviews, additional empirical data should be collected directly from customers in future research to replicate and extend the results presented in this paper.

While we believe that companies and their customers are at the core of facilitating the transition toward the circular economy, a broader societal change involving a variety of entities, including suppliers, service providers, competitors, research institutions, NGOs, and policymakers, is required for accelerating its implementation.

6 | Conclusions

We believe that this study provides a valuable addition to the emerging literature on digital technologies and the circular economy. It ties relevant research streams together and develops a comprehensive view of the use of digital technologies as an enabler of the circular economy, highlighting the role of customer behaviour. As stated by experts interviewed for this study,

> Sustainability is mainly driven via business models. Companies need to show that circular economy makes sense and can be profitable" (i25). "The customers are a central component for the functioning of the circular economy. It does not work without the customers, but it is the companies that need to define the solution (i19).

By focusing on companies in the circular economy and their circular business models, we provide an important contribution that demonstrates a novel approach to enabling the development of a circular economy using existing technologies and engagement with internal and external stakeholders, emphasising the role of the customer.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Endnotes

[1] That is, practice "make spare parts available as producer".

[2] That is, practice "develop a (reverse) supply chain infrastructure with stakeholders".

[3] That is, practice "offer rewards by participating in circular behaviour".

[4] That is, practice "provide transparent information across the product supply chain".

[5] This builds on Tunn et al.'s (2021, 2799) terminology of "frequency of consumer-provider touchpoints" and confirms their findings from a quantitative investigation.

[6] Further influenced by the technology cost for the respective individual und multiple digital technologies evaluated.

[7] That is, "enablement", "education", "environmental restructuring", and "persuasion", "incentivisation", "modelling", "coercion", "training", and "restriction".

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Appendix A

Interview Guide

This guide is intended as basis for conducting **semi-structured interviews with expert respondents** (alternative wording in blue); detailed sub-questions are only to be used if applicable in the interview context, additional aspects may be probed correspondingly; points in grey are prompts that can be shared with interviewees to facilitate answering as required; text *in italics* represents additional interviewer instructions.

Introduction:

- *Introduce interviewee to the research topic:*
  - *Short personal introductions & thank you*
  - *Summary of research project and context*
  - *Focus and aim of the interview*
  - *Admin and other aspects*

Background information:

1. What are your role and responsibilities within your organization?
2. Which topics are you knowledgeable about?
   - ❑ Circular Economy
   - ❑ Sustainability Management
   - ❑ Business Model Innovation / Business Development / Innovation Mgmt.
   - ❑ Digitisation (digital technologies)
   - ❑ Supply Chain Management
   - ❑ Other (please specify)
3. For how long have you gained experience in the field(s) discussed?
4. Which circular economy-related products or services does your organization offer or which product or service innovations are you working on / are you experienced with?
5. How would you describe the customer base you engage with?
   - ❑ B2B / B2C / B2B2C, …

Customer behaviour in the circular economy:

Briefly share definition of 'customer/consumer/user'

"For simplification we will refer to "customers" in our questions. However, please also include information regarding not only actual but also potential users or consumers where adequate in your answers."

6. What are the main CE-specific factors for customer acceptance and why?
   a. What are drivers and barriers of customer acceptance?
   b. What are key challenges in this context and which best practices did you develop / observe to overcome these?
   c. (How) Do those approaches differ from how you / companies proceed with your / their traditional business model / innovations?
7. How do you / do companies engage with customers in the context of COI?
   a. What types of interventions do you / do companies implement to engage with customers and their perspectives? (e.g., co-ideate/ create, integrate feedback, inform/educate, …)
   b. Across which processes, phases or touchpoints?
   c. With which goals and motivation? (e.g., sustainable consumption, ...)

Digital technologies:

Briefly share definition of 'digital technologies'

8. Which digital technologies does your organisation / do organisations you have worked with use (or plan to use in the future) to involve customers or use in general in the context of the circular economy?

- ❑ Internet of things,
- ❑ blockchain,
- ❑ smart sensors,
- ❑ RFID technologies,
- ❑ augmented reality,
- ❑ 3D printing,
- ❑ artificial intelligence,
- ❑ mobile technologies,
- ❑ machine-to-machine communication,
- ❑ advanced robotics,
- ❑ big data/analytics,
- ❑ cognitive computing,
- ❑ cybersecurity
- ❑ other

9. For each of the digital technologies employed ...
    a. What are specific use cases and examples?
    b. What is your / companies' goal in using this digital technology?
    c. What are challenges of using these digital technologies?
    d. What are benefits of using these digital technologies (e.g., customer beh. change)?
    e. Which corporate functions across the supply chain are affected through these digital technologies and how?
        - ❑ Procurement & Inbound logistics
        - ❑ Production & Operations
        - ❑ Outbound logistics
        - ❑ Marketing & Sales
        - ❑ Sustainability
        - ❑ Customer service
        - ❑ R&D
        - ❑ Information Systems
        - ❑ Finance, Controlling & Accounting
10. Implementation of digital technologies:
    a. Which are typical challenges your organisation has / you have experienced in implementing / as part of the implementation of such digital technologies?
    b. Which are best practices to implement such digital technologies to enhance customer acceptance?
    c. How do you incorporate / have you observed the incorporation of such digital technologies in (your) business models (i.e., business model innovation processes)?
        i. Which are the process steps?
        ii. Which stakeholders are involved?

Other:

11. Do you have any documents to share that would substantiate your organisation's / the management in this field (i.e., digital technologies, SCM, CE)
12. Which are other colleagues in your organisation or in other organisations I could talk to about this topic?

Thank you and alignment on next steps (e.g., follow-up call.

Appendix B

Definitions of Key Terminologies of the COM-B Model (Michie et al. 2011)

Category	Term	Definition
Sources of behaviour	Physical capability	Physical capability being the capacity to engage in the necessary activity—doing, acting et al.
	Psychological capability	Psychological capability being the capacity to engage in the necessary thought processes—comprehension, reasoning et al.
	Physical opportunity	Physical opportunity afforded by the environment
	Social opportunity	Social opportunity afforded by the cultural milieu that dictates the way that we think about things (e.g., the words and concepts that make up our language)
	Reflective motivation	Reflective processes (involving evaluations and plans)
	Automatic motivation	Automatic processes (involving emotions and impulses that arise from associative learning and/or innate dispositions)
Intervention functions	Education	Increasing knowledge or understanding
	Persuasion	Using communication to induce positive or negative feelings or stimulate action
	Incentivisation	Creating expectation of reward
	Coercion	Creating expectation of punishment or cost
	Training	Imparting skills
	Restriction	Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviours)
	Environmental restructuring	Changing the physical or social context
	Modelling	Providing an example for people to aspire to or imitate
	Enablement	Increasing means/reducing barriers to increase capability or opportunity (Capability beyond education and training; opportunity beyond environmental restructuring)

Appendix C

Example Use Cases Enabled by Digital Technologies

This section shows exemplary empirically identified use cases to illustrate the interrelationships between factors affecting customer acceptance, practices to address these factors, and enabling digital technologies. For illustration purposes, the examples focus on a single factor and practice per use case, facilitated by multiple digital technologies.

Use Case 1: E-Scooter Rental

This example describes a business model that offers e-scooters as-a-service for urban micro-mobility (i10). The business model aims to be sustainable by intensifying the product's utilisation, prolonging the product's life-cycle through repairs, and offsetting emissions. Given that the e-scooter fleet is constantly used and parked by others, the customer is unaware of the e-scooters' availability, location, and battery level, thus raising the need for "information availability" as a factor for customer acceptance. As a direct response, the rental provider "makes information easily available via information technology in real-time" (i.e., practice). This is achieved through an interplay of different technological enablers (i.e., digital technologies) (Figure C1), which allow the customer to search for the nearest available e-scooter on their mobile device, check battery levels, and identify the optimal route. In this use case, different technological enablers (i.e., "service", "cognition", "interaction layer") were used to support an intervention function (i.e., "enablement") to influence a source of behaviour (i.e., "physical opportunity").

Use Case 2: Power Tool Rental

This example describes a business model that offers the rental of high-end power tools (i16). Instead of selling them, the manufacturer rents the tools in a fleet model and retains ownership, allowing the tools' repair and reuse. Given the tools' premium pricing, customers expect these to deliver at the highest "performance" levels (i.e., factor). To ensure this, the manufacturer "conducts regular quality checks of products" (i.e., practice). Since periodic quality checks would be inefficient, the manufacturer remotely checks the tools' performance between return cycles using multiple technological enablers (i.e., digital technologies) (Figure C2). "Digital twins" of physical assets provide an overview of the tools in the market. "Sensors" record relevant usage data, such as pressure, heat, and runtime, which is uploaded to the cloud. "Predictive maintenance analytics" manages the replacement of tools for repair to ensure optimal performance and avoid downtime. Further, the company shares usage-based recommendations with their customers through their application (i.e., "mobile technology") to help optimise product usage and performance.

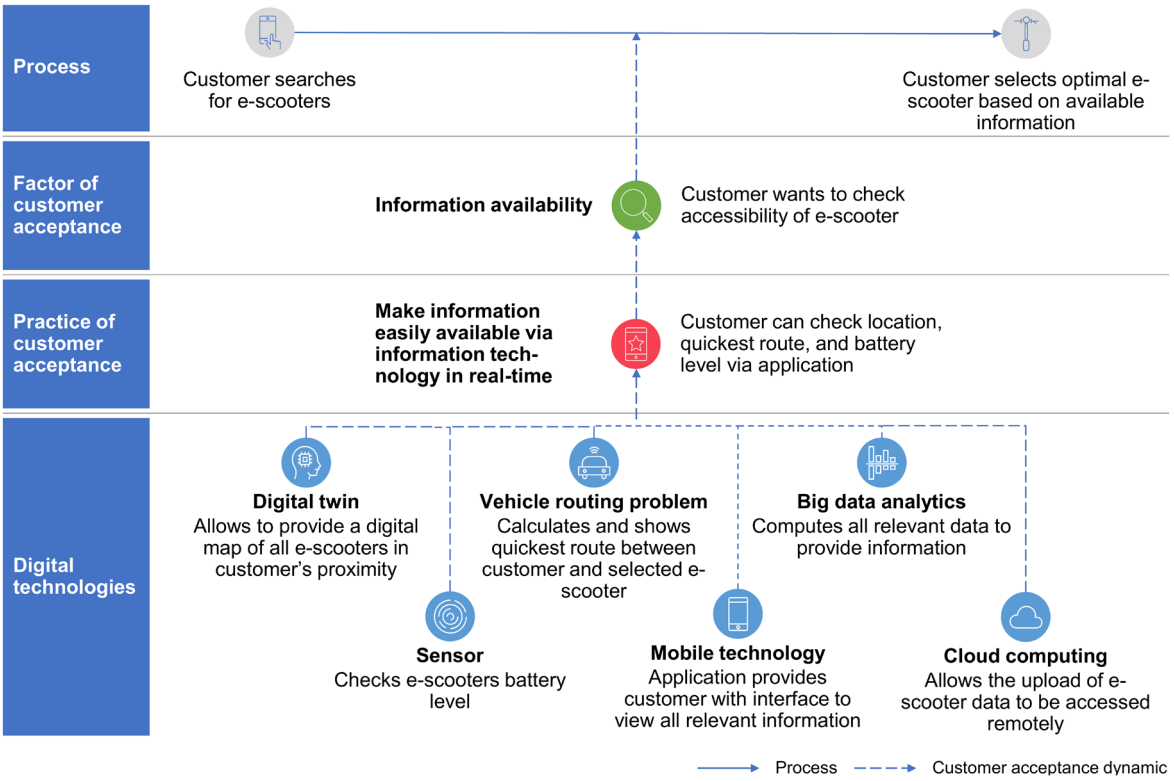

FIGURE C1 | Process depiction of e-scooter rental. [Colour figure can be viewed at wileyonlinelibrary.com]

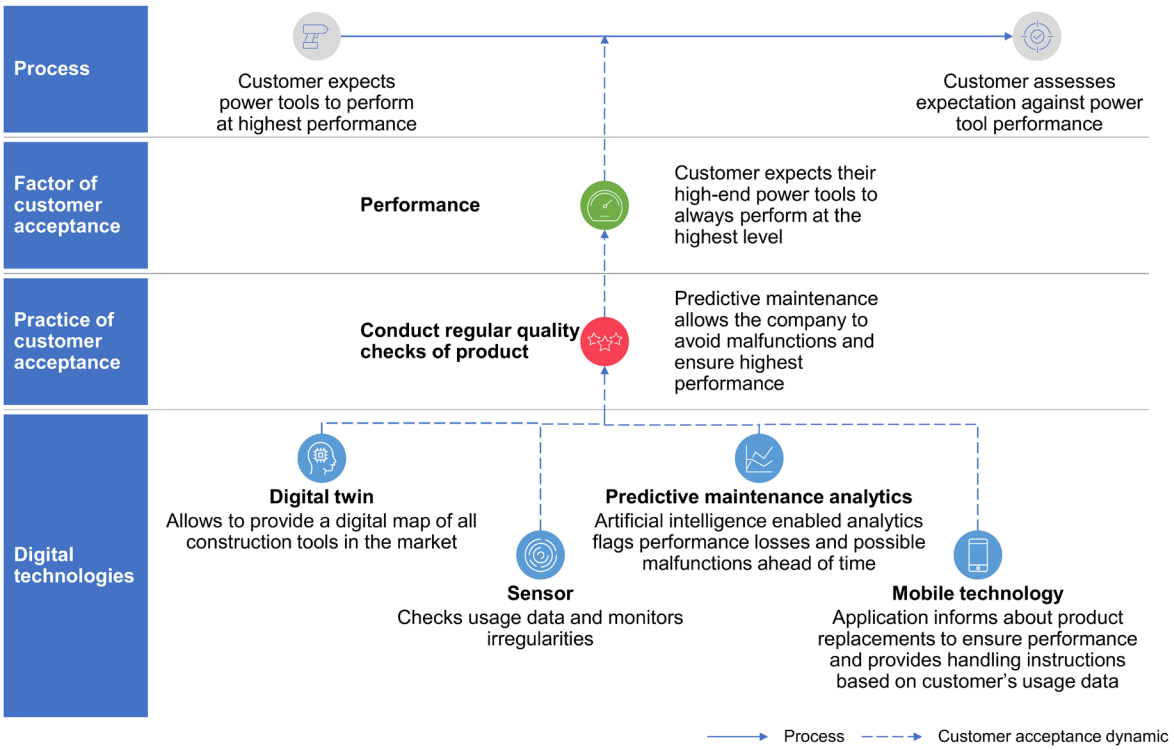

FIGURE C2 | Process depiction of predictive maintenance for power tool rental. [Colour figure can be viewed at wileyonlinelibrary.com]