OmniaScience

Journal of Industrial Engineering and Management
JIEM, 2025 – 18(3): 631-666 – Online ISSN: 2013-0953 – Print ISSN: 2013-8423
https://doi.org/10.3926/jiem.8344

Digital Technologies as an Accelerator for Circular Economy Adoption By Consumers: A Literature Review

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Received: July 2025
Accepted: November 2025

Abstract:

Purpose: Consumer adoption is key for circular economy transition. This study investigates how digital technologies can accelerate consumer adoption of the circular economy by exploring the intersection of circular economy, consumer behavior, and digital technologies.

Design/methodology/approach: This study adopted the PRISMA methodology to conduct a systematic literature review methodology. The criteria for the selection of the articles were the focus on circular economy and digital technologies, and publication on Scopus and Web of Science databases, limited to the fields of Business and Management. Eighty-one selected articles were investigated.

Findings: The results of the investigation indicate that digital technologies such as artificial intelligence, IoT, big data, blockchain, VR, AR, 3D printing, robotics, and mobile apps can enhance consumer trust, consumer engagement, user satisfaction, customer experience, and customer loyalty. These technologies also provide competitive advantages to companies, support circular business models, innovation, new ways of collaboration, sustainable brand image, and enable a better understanding of consumer behavior for customer attraction and retention, customization, and predictive analytics.

Practical implications: Digital technologies can empower consumers to make more sustainable choices and actively participate in the circular economy transition. This highlights how businesses and policymakers could leverage digital technologies to engage consumers in circular economy initiatives.

Originality/value: The research contributes a theoretical framework that integrates consumer roles within the circular economy, digital technologies, and their benefits for consumers, companies, and performance outcomes. This synthesis of insights from circular economy principles, consumer behavior, and digitalization enriches existing circular consumer literature and provides practical insights while identifying areas for future research.

Keywords: circular economy, circular consumer, digitalization, systematic literature review

To cite this article:

Ávila-García, L., Santos, M.F., Prieto-Sandoval, V. (2025). Digital technologies as an accelerator for circular economy adoption by consumers: A literature review. *Journal of Industrial Engineering and Management*, 18(3), 631-666. https://doi.org/10.3926/jiem.8344

1. Introduction

The United Nations Environment Programme (UNEP) Executive Director Inger Andersen (2021) defines circularity as essential to deliver all the environmental multilateral agreements such as the Paris Agreement and the Post-2020 Global Biodiversity Framework. Circular economy plays a pivotal role in achieving Sustainable Development Goals, specifically SDG 12: To ensure sustainable production and consumption as it offers potential solutions to sustainability issues such as resource scarcity, waste generation, and environmental degradation (Geissdoerfer, Savaget, Bocken & Hultink, 2017; Prieto-Sandoval, Jaca & Ormazabal, 2018; Andersen, 2021).

Consumers play a crucial role transitioning towards a circular economy, as their consumption behavior accounts for 72% of global greenhouse gas emissions (Dubois, Sovacool, Aall, Nilsson, Barbier, Herrmann et al., 2019). However, less than 20% of scientific publications address the consumer's role in this transition (Paparella, Vecchio, Cembalo & Lombardi, 2023), highlighting the urgent need for a deeper understanding of consumer engagement in circular initiatives (Camacho-Otero, Boks & Pettersen, 2018; Kirchherr, Reike & Hekkert, 2017; Szilagyi, Cioca, Bacali, Lakatos & Birgovan, 2022; Vidal-Ayuso, Akhmedova & Jaca, 2023). The transition towards a circular economy requires consumers to actively participate by changing their purchasing behaviors (European Commission, Cerulli-Harms, Suter, Landzaat, Duke, Rodriguez-Diaz et al., 2018), which includes promoting recycling, adopting alternative products like remanufactured and repaired items, and embracing new business models such as renting and reselling (Planing, 2018; Wang, Zhu, Krikke & Hazen, 2020).

Over the next ten years digitally facilitated platform business models will be responsible for creating 70% of new economic value (World Economic Forum, 2023). Digital technologies, including internet of things (IoT), big data, and data analytics, promise to drive production and consumption toward circular economy principles (Kristoffersen, Blomsma, Mikalef & Li, 2020; Liu, Trevisan, Yang & Mascarenhas, 2022). These technologies facilitate resource optimization, support circular business models, enhance supply chain transparency, and foster collaboration and innovation (Cagno, Neri, Negri, Bassani & Lampertico, 2021).

Moreover, digital technologies are anticipated to empower consumers by providing information, education, and opportunities for active participation in the transition to circular economy (Piscicelli, 2023). Specifically, they empower consumers to make sustainable choices, enhance consumer engagement, and foster efficiency and transparency (Sánchez-García, Martínez-Falcó, Marco-Lajara & Manresa-Marhuenda, 2024). These technologies enable resource sharing, facilitate sustainable purchase decisions, and promote participation in recycling processes. Looking ahead, the adoption of circular economy principles is expected to improve customer experience, enhance enterprises' competitive advantage, and enable a better understanding of market demand and consumer behavior for personalized services (Chi, Liu, Wang & Osmani, 2023).

Research gaps in consumer behavior offer opportunities to explore how new consumption models and digitalization influence consumer decisions and habits (Camacho-Otero et al., 2018; Vidal-Ayuso et al., 2023). Existing studies concentrate heavily on the supply side applications of Digital Technologies (DTs), such as manufacturing processes, supply chain management, and remanufacturing (Neri, Cagno, Susur, Urueña, Nuur, Kumar et al., 2024; Mora-Contreras, Pérez-Lopez, López-Hernández & Acevedo-Suárez, 2025), while consumer centric perspectives are less developed (Bücker, Pantel, Geissdoerfer, Bhattacharjya & Kumar, 2025). The active role of consumers in CE adoption is still insufficiently examined (Szilagyi et al., 2022), and existing frameworks provide limited insight into how DTs influence consumer acceptance (Kristoffersen et al., 2020). Moreover, the mechanisms for sustaining circular consumer behaviors are not yet well understood, particularly in the post-purchase phase, which encompasses use, recycling, and upcycling (Paparella et al., 2023; Szilagyi et al., 2022). Research has also not adequately examined the potential inhibiting effects of digital technologies on consumer acceptance due to unfamiliarity or lack of confidence in new digital tools.

To address these critical gaps, this study adopts a consumer-centric analytical lens and makes three key contributions. First, we explicitly delineate factors affecting customer acceptance of circular consumption, a development that previous reviews lacked. Second, we identify Digital Technologies enabled practices that companies deploy to influence consumer acceptance, clarifying how specific DTs overcome traditional consumer barriers. Third, we provide a conceptual framework that maps intricate relationships, identifying opportunities for future empirical investigations.

Therefore, this article addresses the following research questions:

RQ1. What is the current state of knowledge regarding the intersection of circular economy, consumer behavior, and digitalization?

RQ2. How can concepts from circular economy, consumer behavior, and digitalization be integrated into a theoretical framework?

RQ3. What are the most promising directions for future research in this field?

To answer these research questions, the present study undertakes a systematic literature review to examine the literature on circular economy (CE), consumer behavior (CB), and digitalization. A total of 240 papers were examined, and 69 directly related to the focus of this paper were selected. A new conceptual framework that identifies the multi-layer role of consumer collectives in the circular economy is proposed. This study contributes to circular economy research and specifically to the emerging circular consumption literature in the following ways: The framework helps managers identify digital functions and technologies that support their consumer-faced circular economy strategies. It also suggests areas for future research on digital applications in circular business models.

The article is structured as follows. The following section summarizes the related works on the circular economy, consumer behavior, and digitalization. Section 3 describes the circular economy, digital technologies, and barriers. Section 4 describes the methodology of our systematic literature review. Section 5 summarizes the results of the bibliometric analysis and discusses the main research findings, implications, and possible future research agendas. Finally, Section 6 draws some limitations and Section 7 draws the conclusions.

2. Circular Economy, Circular Consumer, and Digitalization

Transitioning to a circular economy by 2050 requires a commitment from society to a carbon-neutral, toxic-free, and sustainable model (European Parliament, 2021). The traditional "take-make-waste" model has given rise to today's challenges, including resource scarcity, climate change, and environmental degradation. However, consumers, representing the demand side, play a crucial role in influencing the long-term implementation of the Circular Economy (CE) and the introduction of eco-innovative products in the market (Prieto-Sandoval et al., 2018).

Thus, this section explores the link between the CE context and commonly referenced R frameworks which include the traditional 3R (reduce, reuse, recycle), 4R (reduce, reuse, recycle, and recover), and 6R which includes rethinking, refuse, and repair. Potting, Hekkert, Worrell and Hanemaaijer (2017) propose a 10R framework organized into three levels of circularity: smarter product use and manufacture (refuse, rethink, and reduce), extended lifespan of products and their parts (reuse, repair, refurbish, remanufacture, and repurpose) and useful application of materials (recycle and recover).

Considering the objective of the circular economy is to create sustainable, equitable, and resilient systems for people, businesses, and the environment; One Planet Network (2023) grouped the circular economy approaches under three broad categories: rethinking product design and manufacturing (refuse, rethink and reduce), extending the lifespan of products and their parts (reuse, repair, refurbish, remanufacture and repurpose), and the effective reuse of material (recycle and recover). In this way, circular behavior, which refers to a set of actions and practices that contribute to the principles of the circular economy, encompasses reducing, reusing, and rethinking product design and manufacturing, activities that aim to minimize waste generation and maximize resource efficiency (Canto, Grunert & Barcellos, 2021; Wastling, Charnley & Moreno, 2018).

Consequently, the consumer decision processes should be understood in depth. The literature identifies three key stages or phases where consumers favor linear or circular economy solutions: the point of acquiring a product, the use phase, and the end of use (Wastling et al., 2018). Consumers are directly involved in these three key stages of a product lifecycle: purchase, use, and end-of-life (EoL) management. Consumer behavior and decision-making during these stages directly affect the success of circular economy initiatives, including reuse, repair, and recycling (Parajuly, Fitzpatrick, Muldoon & Kuehr, 2020). In the circular economy, consumers have three dimensions:

customer, user, and EOL product holder (Shevchenko, Saidani, Ranjbari, Kronenberg, Danko & Laitala, 2023). While social media and various other factors do play a role in consumer decision-making, the key stages are typically acquisition, usage, and end-of-life (European Environment Agency, 2021).

CE R dimensions (Potting et al., 2017)	**CE approach** (One Planet Network, 2023)	**Role of the consumer in the CE** (Shevchenko et al., 2023)
R0 Refuse R1 Rethink R2 Reduce	Rethinking product design and manufacturing	Customer *Acquisition of products with minimum environmental impacts *Refraining from buying for closing and slowing the loop
R3 Reuse R4 Repair R5 Refurbish R6 Remanufacture R7 Repurpose	Extend the lifespan of products and their parts	User *Careful use and maintenance *Repairing services *Reselling or gifting items that are no longer required
R8 Recycle R9 Recover	Effective reuse of materials	EOL product holder *Timely discarding *Appropriate circular discarding channel

Table 1. CE approaches and the role of consumers based on CE dimensions and consumer behavior based on the circular economy approach defined by One Planet Network (2023), the 10R Framework (Potting et al., 2017), and the tridimensional role of the consumer in the CE (Shevchenko et al., 2023)

Regarding Table 1, the three circular economy approaches associated with the role of the consumer are structured as follows:

- Approach 1: The consumer as a customer (Purchase stage): Customers adopt pro-environmental practices that contribute to reducing the demand for resources in the long term.
- Approach 2: The consumer as a user (Usage stage): Users are responsible for using and extending the life cycle of products, adopting alternative products like remanufactured and repaired items, and embracing new business models such as renting and reselling.
- Approach 3: The consumer as an EOL product holder (Disposal stage): EOL product holders minimize waste generation.

2.1. The Consumer as A Customer: Purchase Stage

Many research studies have concentrated on determining the particular factors, perceptions, typologies, and motivations that encourage or discourage consumers from adopting or participating in circular solutions (European Environment Agency, 2021).

To support the progression of the circular economy, consumers must be open to transitioning from buying brand-new items to considering remanufactured, refurbished, or reused products (Wang et al., 2020). However, this transition can pose challenges as specific consumers perceive these products negatively. For example, some consumers believe remanufactured products are of lower quality compared to new ones, which may affect their willingness to pay for them (Wang, Wiegerinck, Krikke & Zhang, 2013). Additionally, some consumers need more trust in the remanufacturing process, which can influence their perception of the safety and reliability of remanufactured products (Hazen, Overstreet, Jones-Farmer & Field, 2012). Furthermore, some consumers view reused products as dirty (Wang et al., 2020).

Several studies have utilized theoretical models to construct frameworks for examining consumer behavior within the circular economy. Some notable theories include the theory of planned behavior, perceived risk, and the signaling theory. For instance, the theory of planned behavior (TPB), as proposed by (Ajzen, 1991), supports that behaviors are influenced by intentions, which are determined by three factors: attitudes, subjective norms, and perceived behavioral control. Wang et al. (2020) mentioned the theory of planned behavior in the context of remanufactured products. They concluded that consumers' positive attitudes towards remanufactured products favorably impact their intention to use such products.

The Theory of Perceived Risk (TPR) is a conceptual framework that explains how consumers perceive and assess the potential risks of purchasing a product or service. The TPR suggests that consumers' perceptions of risk can be categorized into several types: functional, physical, financial, social, and psychological. In the context of remanufactured products, the TPR holds relevance because consumers may perceive more significant risks concerning the quality and reliability of remanufactured items when compared to new products (Wang et al., 2013).

Regarding these theories, some scholars have developed models to understand consumer behavior towards circular products. For instance, Wang et al. (2013) developed a model to understand consumer behavior towards remanufactured products. Their research showed that consumers' willingness to purchase remanufactured products is positively impacted by their attitude toward purchasing, subjective norms, and perceived control over their behavior. They further identified several factors influencing consumers' attitudes, such as perceived benefits, knowledge of the product, and perceived risk.

Other theories include signaling theory, which was used to explain how different types of information can influence consumer perceptions of remanufactured products. Some of the solutions presented to switch consumer perceptions towards remanufactured products are: providing consumers with more information about the product history, highlighting the environmental benefits such as reduced waste and resource consumption, offering incentives such as discounts or loyalty programs, educating consumers about the benefits of the circular economy and collaborate with stakeholders across the value chain to promote the adoption of circular economy practices (Wang et al., 2020). Hazen, Boone, Wang and Khor (2017) developed an instrument to measure the perceived quality of remanufactured products based on the signaling theory.

2.2. The Consumer as A User: Usage Stage

Efforts to extend the lifespan of products are gaining increasing recognition in both academic research and practical applications (Wang et al., 2013). According to Bakker, Mugge, Boks and Oguchi (2021), extending the life of a product is a significant way to promote a circular economy by designing products to be durable and suitable for reuse, repair, refurbishment, and remanufacturing. However, it's important to remind consumers of their role in the product's lifespan within a circular economy, encouraging them to actively maintain or repair their products when possible. For instance, and according to Cooper (2004), consumer attitudes toward product obsolescence vary, as some users replace items for functional or aesthetic reasons, while others desire new features, leading to technological obsolescence. Environmental benefits and longer-lasting appliances are not always recognized, but consumers seek information on product lifespans, meaning that consumers need to be better informed about the environmental impact of their consumption patterns and that they need to be incentivized to repair work and purchase second-hand products.

There are various design strategies, including simple maintenance and repairs, a "long life" assurance, modular product structure, versatility, and a strong connection between the user and the product, which can help extend the lifespan of products (Mugge, Schoormans & Schifferstein, 2005). Consumer behavior research has focused on purchase behavior, and there is an opportunity to expand research into the post-purchase stage of the consumer journey, specifically on how consumers form emotional bonds with products and how these bonds influence their behavior over time (Mugge, Schifferstein & Schoormans, 2005). Mugge, Schifferstein and Schoormans (2008) mention the concept of product attachment as valuable for companies because it increases consumers´ loyalty to the brand and, at the same time, contributes to a sustainable society as consumers tend to keep products to which they experience attachment for a more extended period.

Product-service systems have a key role in promoting resource efficiency and circularity. In a PSS, the customer pays for the use of a product rather than owning it outright (Tukker, 2015). The concept of PSS suggests that customers are interested in a product's function rather than the physical product itself. Therefore, a profit can be made by offering the product's function rather than focusing solely on selling the tangible product (Mont, 2001). This can include leasing, renting, or pay-per-use models, where the manufacturer retains ownership of the product and is responsible for maintenance, repair, and end-of-life disposal (Tukker, 2015). Consumers' benefits from PSS include the diversity of choices, maintenance service, flexible payment options, and personalization of products while alleviating long-term ownership responsibilities and promoting environmentally conscious consumption (Mont, 2002). However, some barriers to the adoption of PSS by consumers include the preference for products over services (Mont, 2004) and the need for more awareness and understanding of PSSs by consumers (Mont, 2002).

Industry 4.0 technologies such as automation, artificial intelligence, and real-time data interpretation play a significant role in fostering the impact of the circular economy on companies (Massaro, Secinaro, Dal-Mas, Brescia & Calandra, 2021). In this line, Tunn, Van-Den-Hende, Bocken and Schoormans (2020) examined how digitalization affects consumer perceptions of product-service systems. Based on surveys and interviews, their study indicates a notable influence of short-term PSS on digital media, contributing to consumer views on digitalizing PSS.

Through extensive literature research, Fachbach, Lechner and Reimann (2022) identified a comprehensive set of factors that drive the intention to repair. These factors encompass concerns about environmental protection, social acceptance, and economic considerations, as well as socio-demographic variables, past behavior, and perceived repair difficulty. These factors influence individuals' decisions regarding the use of repair service providers, attempting self-repair, and utilizing repair service providers within a repair network.

2.3. The Consumer as A User: Usage Stage

According to Islam, Huda, Baumber, Shumon, Zaman, Ali et al. (2021), various factors impact how consumers deal with e-waste disposal and recycling. These factors include infrastructure, education, technical knowledge, socio-demographic factors, moral norms, environmental beliefs, and social pressure. Furthermore, there is a connection between incentives and the willingness of individuals to take part in online recycling platforms. In terms of food consumption, consumer-generated food waste can be attributed to three main categories: lack of awareness, excessive consumerism, and personal preferences/habits (Jabbour, Jabbour, Godinho-Filho & Roubaud, 2018). Food waste generation tends to increase in large households with higher employment, income, and education levels.

The study featured in Parajuly (2017) thesis utilized the Kano model to assess product attributes to investigate user acceptability concerning end-of-life (EoL) scenarios for electrical and electronic appliances. This model aids in identifying which product attributes are essential, desired, or need improvement for a product's commercial success. The study examined EoL options like reuse, remanufacturing, and recycling as potential product attributes during the design phase. The research discovered that maximizing the potential for reuse was the most appealing EoL option among participants. Furthermore, an extended Kano analysis revealed that different user segments placed varying importance on EoL options, with women displaying a stronger preference for considering EoL factors and a greater willingness to pay a premium for environmentally friendly electronic products than men.

Gomes, Moreira and Ometto (2022) conducted a systematic literature review to identify and classify circular consumer behaviors. They highlighted three primary behaviors: acquiring recycled, remanufactured, or reconditioned products; caring for and maintaining products; and returning products at the end of their lifecycle. The authors further expanded this classification to encompass 15 distinct circular consumer behaviors, organizing them across six stages of the consumption process: pre-acquisition, during acquisition, post-acquisition, pre-utilization, during-utilization, and post-utilization. These behaviors can be mapped to the three consumer roles (customer, user, and EOL product holder) as presented in Table 2, providing a comprehensive framework for understanding circular consumer behavior throughout the product lifecycle.

Despite these contributions, several gaps remain. Most of the existing work concentrates on purchase intentions rather than actual behaviors, creating an intention–behavior gap (Parajuly, 2017; Wang et al., 2020). Consumer studies often emphasize technical or attitudinal aspects while underexploring post-purchase practices such as repair, reuse, and responsible disposal (Mugge, Schifferstein et al., 2005; Fachbach et al., 2022). Research is also fragmented, with limited integration of digital technologies that could enable or incentivize consumer participation. As Bücker et al. (2025) note, studies on digitalization and CE remain largely conceptual or single technology focused, with insufficient empirical evidence on how companies can leverage digital tools to enhance customer acceptance of circular business models. Similarly, Neri et al. (2024) stress that the nexus of CE and digitalization has been addressed mainly from a supply-side or firm-level perspective, leaving consumption and consumer acceptance underexplored.

CE approach - consumer	Consumer circular behaviour (Gomes et al., 2022)
The consumer as a customer (Purchase stage)	Acquire recycled, remanufactured, or reconditioned products
	Reduce consumption
	Use refills
	Consume locally
	Consume organic products
	Acquire certified green products
	Adopt use-oriented products and services
The consumer as a user (Usage stage)	Care for and perform maintenance on products
	Reuse goods
	Share products and services
	Save energy and water
The consumer as an EOL product holder (Disposal stage)	Return products at their end-of-life
	Recycle goods
	Dispose of product/waste appropriately
	Separate waste

Table 2. CE approaches are based on the consumer roles framework. Based on Gomes et al. (2022) Role of consumer mindsets, behavior, and influencing factors in circular consumption systems: A systematic review

3. Circular Economy, Digital Technologies and Barriers

According to Fehrer and Wieland (2021), integrating new technologies and innovative design approaches is crucial for businesses aiming to achieve sustainability and social goals within a systemic business model innovation process. Digitalization could enable the circular economy (Antikainen, Uusitalo & Kivikytö-Reponen, 2018) and there is an opportunity to assess the role of digital technologies in enhancing consumer awareness and decision-making regarding sustainable and circular choices, with a specific focus on how digitalized systems contribute to informed consumer decision processes. The implications of adopting digital technologies for implementing circularity at the level of individual companies and industries are still under-researched; in particular, (Shashi, Centobelli, Cerchione, & Jhamb, 2024) suggested that further research into the role of digital technologies in developing circular business models is required.

There is a necessity to delve deeper into how digital technologies, by interacting with consumers, can impact user behaviors in favor of circular and sustainable consumption patterns (One Planet Network, 2023). Understand drivers and barriers for circular behavior (European Environment Agency, 2021) and how technology influences them. To tackle those challenges, a transformation towards sustainable consumption patterns is urgently needed (One Planet Network, 2023). Digital technologies (DTs), such as the Internet of Things (IoT), big data, and data analytics, are considered essential enablers of the circular economy (Kristoffersen et al., 2020).

Given that both CE and DTs are new and developing areas, there is currently a lack of systematic guidance on applying DTs to fully realize the benefits of circular strategies for enhancing resource efficiency and productivity (Kristoffersen et al., 2020). According to Dwivedi, Sharma, Rana, Giannakis, Goel and Dutot (2023), there is a growing scholarly interest in understanding how consumers interact with AI technologies. Agrawal, Wankhede, Kumar, Luthra, Majumdar and Kazancoglu (2021) and Agrawal, Wankhede, Kumar, Upadhyay and Garza-Reyes

(2022) conclude that customer involvement is necessary for creating innovative sustainable circular products using digitalization, highlighting the implications for businesses.

While research has explored what motivates people to engage in circular consumption practices, there's a gap in our understanding of how consumers view the digital tools that enable circular business strategies (Saidani, 2022) we also understand that initiatives addressing consumers are critical for making a transition towards CE and those are still largely missing (Ajwani-Ramchandani, Figueira, Torres-de-Oliveira, Jha, Ramchandani & Schuricht, 2021). While research has explored what motivates consumers to engage in circular consumption, there's a gap in our understanding of how consumers view the digital technologies that enable circular business models (Saidani, 2022).

The most significant shared classification for digital technologies is the one proposed by Rüßmann, Lorenz, Gerbert, Waldner, Engel, Harnisch et al. (2015) which includes: autonomous robots, simulation, systems integration, industrial internet of things, additive manufacturing, cybersecurity, big data and analytics, augmented reality, and cloud computing. However, Ertz, Sun, Boily, Kubiat & Quenum (2022) in their study on Industry 4.0 in the promotion of circular product lifetimes, selects four key constructive technologies for I4.0 which include: Additive Manufacturing, Artificial Intelligence, Internet-of-things, and Big Data. Toth-Peter, Torres-de-Oliveira, Mathews, Barner & Figueira (2023), discuss six Industry 4.0 (I4.0) technologies that support the transition to circular business models which include: the Internet of things, artificial intelligence, blockchain, big data, additive manufacturing/3D printing, and augmented reality.

Industry 4.0 and digital technologies, particularly Big Data, are driving the textile industry's transition to circular economy practices by enabling real-time data transfer, improving product design, prototyping, and recycling efficiency (Araque González, Suárez-Hernández, Gómez-Vásquez, Vélez-Uribe & Bernal-Avellaneda, 2022).

According to this last classification, six DTs can be identified in Table 3.

Digital Technology	Definition	Source
Artificial Intelligence	The capability of a system to accurately understand outside information, acquire knowledge from this data, and apply these insights to accomplish particular objectives and tasks through flexible adjustment.	Ertz et al. (2022)
Internet of things	Technology allows for wireless communication between sensors, computers, and human devices, enabling data access from anywhere.	Patyal, Sarma, Modgil, Nag and Dennehy (2022)
Big Data Analytics	A combination of tools, methods, and procedures that combine organized, semi-structured, and unstructured data and processes to facilitate better decision-making.	Gebhardt, Kopyto, Birkel and Hartmann (2022)
3D and additive manufacturing	Creating products by depositing materials layer by layer using 3D models allows for decentralized parts manufacturing without requiring specialized tools.	Gebhardt et al. (2022)
Blockchain	A decentralized and unalterable peer-to-peer system where transaction details are stored within digital data blocks and distributed across numerous identical and accessible ledgers.	Gebhardt et al. (2022)
AR/VR	Augmented reality technology enables individuals to combine real and virtual environments, engage in real-time interactions, and accurately align virtual and real objects in three dimensions.	Patyal et al. (2022)

Table 3. Digital Technologies Definitions

While numerous papers have delved into the intersection of digital technologies and the circular economy, a significant portion of them overlook the pivotal role of the consumer. Prior works have made valuable contributions: for instance, Agrawal et al. (2021) and Agrawal et al. (2022) and Bressanelli, Adrodegari, Pigosso and Parida (2022) proposed frameworks linking Industry 4.0 technologies with circular business models; Esmaeilian, Sarkis, Lewis and Behdad (2020) and Ranta, Aarikka-Stenroos and Väisäenen (2020) presented case-based and conceptual insights on DT applications; and Saidani (2022) highlighted the importance of consumer perspectives in CE adoption. More recent studies, such as Charnley, Knecht, Muenkel, Pletosu, Rickard, Sambonet et al. (2022) and Khatami, Vilamová, Cagno, De Bernardi, Neri and Cantino (2023), provided illustrative examples of DT-enabled practices. However, these contributions remain fragmented and largely conceptual, often focusing on isolated technologies or supply-side efficiencies, while neglecting systematic integration of consumer acceptance. As emphasized by Bücker et al. (2025), true scalability of circular business models depends not only on sustainability but also on core factors such as price, quality, and convenience—dimensions underexplored in prior research.

4. Methodology

This study carried out a systematic literature review (SLR) to map the knowledge on circular economy, consumer behavior, and digitalization, propose a theoretical framework, and propose a future research agenda. Following Fink (2010: page 2), a literature review is a "systematic, explicit, and reproducible method for identifying, evaluating, and synthesizing the existing body of completed recorded work produced by researchers, scholars, and practitioners". Systematic reviews, as emphasized by Snyder (2019), reduce bias, enhance reliability and generalizability, and are widely recognized as a gold standard in business research.

Thus, an SLR was conducted to identify the intersections between circular economy, consumer behavior, and digitalization, and to provide an overview of the research to date related to this topic. This SLR was conducted according to the approach described by Snyder (2019) and was divided into four phases: designing the review; conducting the review; analyzing; and writing the review.

First, in the design phase, it was necessary to understand the motivation and the importance of the topic for the academy by identifying the research questions. Subsequently, the type of approach and methodology to be used was chosen to arrive at the answers to the questions posed. Then, in the phase of conducting the review, the keywords and the inclusion and exclusion criteria were decided upon, to ensure that the selection of the final sample was well performed, utilizing the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology. In the third phase, analysis, it was decided how the chosen papers would be analyzed using both bibliometric and content analysis techniques. Finally, in the writing phase, it was decided to prepare the review using the PRISMA 2020 guidelines, following the guides stated in the reports (Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow et al., 2021), ensuring transparency and reproducibility. Similar approaches have been used in recent research on Industry 4.0 and logistics (Basulo-Ribeiro & Teixeira, 2024; Valenzuela-Cobos, Espinoza-Montero, Salazar-Sepúlveda, Cárdenas-García & Jara-Prado, 2025).

4.1. Data Collection

The review protocol (Tranfield et al., 2002) defined the scope, keywords, and databases. Searches were conducted in Scopus and Web of Science between 2013 and 2024, limited to the fields of Business and Management. The keywords used in the search were divided into three major groups, detailed in each of the columns of Table 4: circular economy; consumer-related terms; and digitalization and the whole new era of digital transformation and Industry 4.0. Table 4 shows the final search strategies used in each database, as well as the number of articles obtained in each case.

In an initial search, 305 titles were found, 241 from Scopus and 64 from Web of Science, 61 of which are present in both databases and are referenced as duplicates.

CE related keywords	Consumer related keywords	Digitalization related keywords
Circular economy	Consum* Customer	Technology* Digital* Industry 4.0

Table 4. Keywords used in the bibliographic review

The result is 244 articles, to which exclusion criteria were applied, referring to language, type of document, area restriction, and the scope of each document.

The exclusion criteria adopted in the search is presented in Table 5.

Criteria	Inclusion	Exclusion
Study Type	Peer-reviewed articles and reviews	Conference papers and articles
Language	English	Other languages
Area	Business and economics	Other areas
Relevance	(a) Circular economy and digital technologies or Industry 4.0 (b) In the context of consumption in the circular economy (c) Role of user, consumer, customer, or purchaser	– Does not focus on circular economy and digital technologies or Industry 4.0 – Does not focus on consumption within the circular economy (e.g., leadership, construction, finance, industry, education, operations) – Does not mention the role of the user, consumer, customer, or purchaser

Table 5. Review protocol for content analysis

Taking the above criteria into account, Table 6 shows the final search strategies used in each database, as well as the number of articles obtained in each case.

Database	Search string	Results Obtained
SCOPUS	(TITLE-ABS-KEY ("circular economy") AND TITLE-ABS-KEY (consumer* OR customer) AND TITLE-ABS-KEY (technolog* OR digital* OR "industry 4.0")) AND (LIMIT-TO (SUBJAREA, "BUSI")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND (LIMIT-TO (LANGUAGE, "English"))	182
WEB OF SCIENCE	"Circular economy" (All Fields) and consum* OR customer (All Fields) and tecgnolog* OR digital* OR "industry 4.0" (All Fields) and Article or Review Article (Document Types) and Management or Business (Web of Science Categories) and English (Languages)	123

Table 6. Selected keywords

From these 305 articles, after removing duplicates (n=65), 240 articles remained. The title and abstract were then read, and studies not focusing on the scope were excluded (n=153), leaving 69 articles. Finally, these 69 articles were read in full to assess their eligibility and relevance to the research questions.

Both the screening and eligibility process was conducted by the authors. In cases of differing opinions, detailed discussions were held to reach a consensus, thus ensuring the integrity and accuracy of the review. This collaborative approach ensured a balanced and thorough assessment of the included studies.

To identify additional relevant articles from the reference lists of the primary articles, snowballing (as a search method) was then applied, with 12 studies being added this way. All of this information is schematized in Figure 1, developed according to the PRISMA 2020 guidelines (Page et al., 2021).

4.2. Data Extraction and Analysis

The 81 selected papers' results were downloaded from the SCOPUS and WEB OF SCIENCE database in .csv format and imported into VOSViewer software to proceed with bibliometric analysis. Research questions 1 and part of RQ3 were answered using bibliometric analysis, including cluster analysis and co-occurrence mapping of keywords, authors, and citations. Research questions 2 and the remainder of RQ3 were answered by means of qualitative content analysis, with a full reading of the articles and synthesis of insights, focusing on contributions, weaknesses, and gaps across studies.

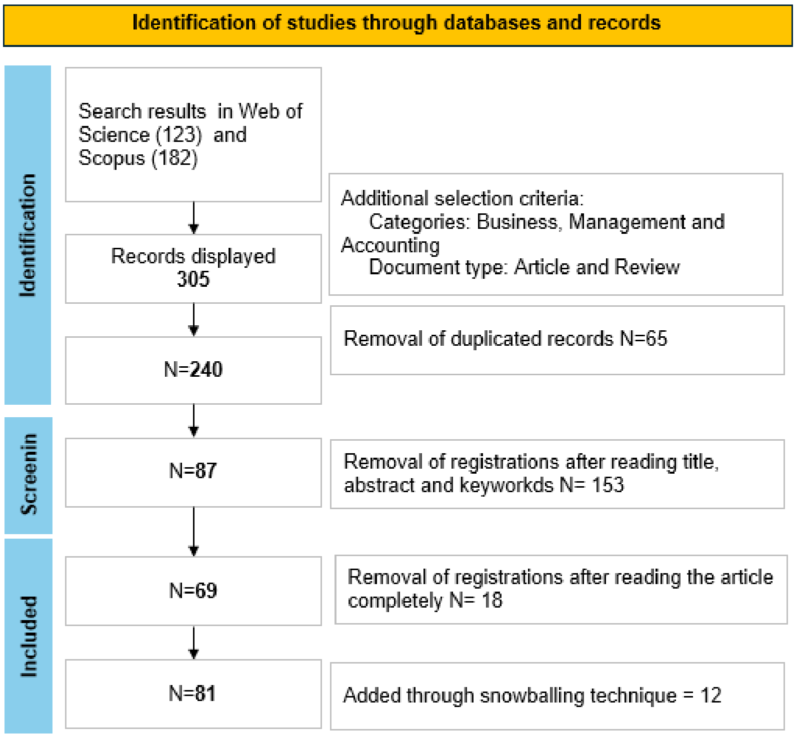

Figure 1. PRISMA flowchart of the article selection process in the systematic review stage

4.3. Data Extraction and Analysis

Bibliometric data from the 81 selected papers were downloaded in CSV format from Scopus and analyzed using VOSviewer software, which enabled cluster analysis and co-occurrence mapping of keywords, authors, and citations. Additionally, a qualitative content analysis was performed to synthesize insights, focusing on contributions, weaknesses, and gaps across studies.

4.4. Reporting

Finally, the results were structured to (1) describe the state of the literature through bibliometric indicators, (2) synthesize contributions, weaknesses, and research gaps through content analysis, and (3) develop a conceptual framework linking circular economy, consumer behavior, and digital technologies, along with a future research agenda.

5. Results

5.1. Descriptive Analysis

This subsection presents a descriptive analysis of the 81 papers selected for this study. It includes the articles published by year, prominent journals, and leading authors.

Figure 2 illustrates that the number of articles published per year has been gradually increasing, with a notable surge from 2021 to 2022 and a continued growth trend up to 2023. The data for 2024, representing only six months (January to June) already shows a substantial number of publications, suggesting a potentially higher publication rate than previous years, with a projection of over 28 articles on these topics by the end of 2024.

Figure 3 shows the distribution of research across major journals. The largest share of publications appears in Technological Forecasting and Social Change, which focus on themes such as AI-enabled circular business models, big data practices, consumer willingness to adopt CE services, and digitalization in SMEs, reflecting its role in shaping the theoretical and managerial debate. The Journal of Cleaner Production also represents a leading journal in this area, with contributions that include studies on waste-to-resource decision systems, IoT-based e-waste return, WhatsApp-based secondhand trading, and systematic reviews of circular supply chains, highlighting its practical orientation toward production systems and consumer engagement. Other influential outlets include the Journal of Business Research, which concentrates on consumer adoption, SMEs, and blockchain-enabled platforms; the International Journal of Productivity and Performance Management, which explores barriers and managerial enablers of digitalization for CE; and the International Journal of Production Economics, which addresses product design, supply chain practices, and sustainable-oriented innovation.

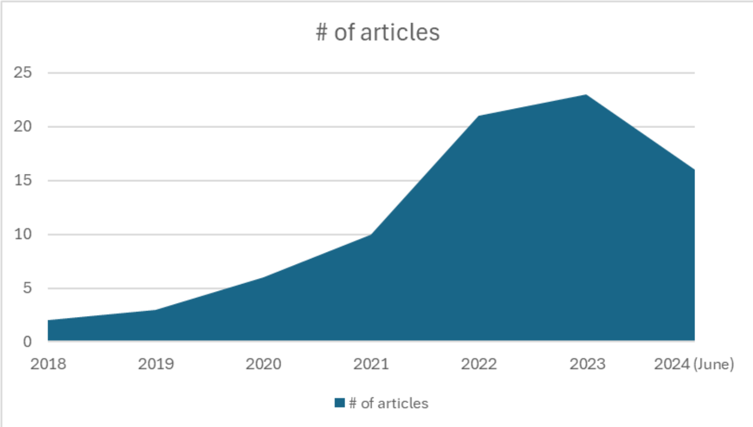

Figure 2. Number of articles per year

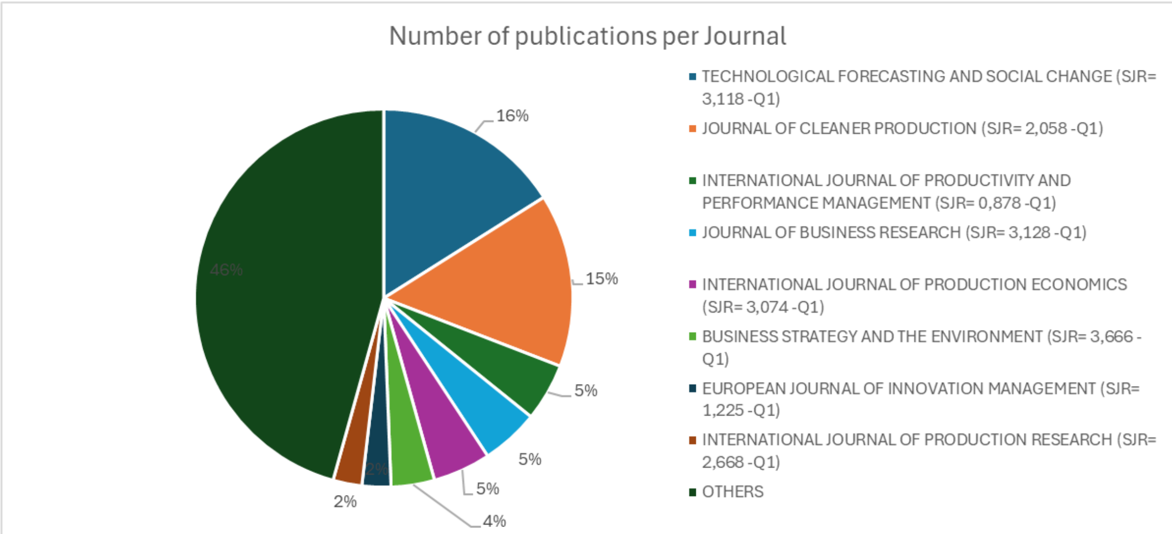

Figure 3. Number of publications per journal

The analysis reveals a diverse set of authors contributing to the field, with some authors having multiple publications. In Figure 4 Belhadi, Kamble, and Kumar are among the authors with the highest number of publications. Belhadi and Kamble's joint publications explore the intersection of advanced digital technologies such as big data and blockchain with circular economy principles, focusing on their application in manufacturing, retail, and design processes across auto-component, apparel, and general manufacturing industries (Dahmani, Benhida, Belhadi, Kamble, Elfezazi & Jauhar, 2021; Jain, Kamble, Ndubisi, Shrivastava, Belhadi & Venkatesh, 2022; Kamble, Belhadi, Gunasekaran, Ganapathy & Verma, 2021). Kumar examines barriers to adopting Industry 4.0 technologies in sustainable food supply chains from a circular economy perspective, explores the relationship between circular economy and sustainable business performance in the context of digitalization, and focuses on the applications of Artificial Intelligence in enhancing the adoption and implementation of circular economy practices (Agrawal et al., 2021; Agrawal et al., 2022; Kumar, Mangla & Kumar, 2024).

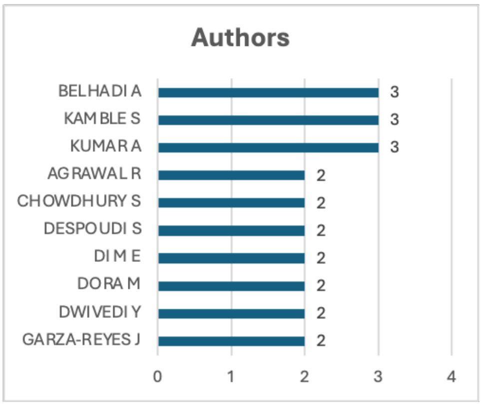

Figure 4. Most prolific authors with more than two publications

The most cited articles address diverse but complementary themes. Kumar, Singh and Dwivedi (2020) and Rajput and Singh (2019) focus on the barriers and challenges of applying Industry 4.0 technologies in SMEs and their integration with the circular economy, highlighting issues such as lack of motivation, fear of failure, and interoperability constraints. Vehmas, Raudaskoski, Heikkilä, Harlin and Mensonen (2018) examine consumer attitudes toward circular fashion, stressing the need for clearer communication and enhanced customer experience. Rodríguez-Espíndola, Cuevas-Romo, Chowdhury, Díaz-Acevedo, Albores, Despoudi et al. (2022) provide evidence from Mexican SMEs, showing how government support and customer pressure foster sustainable-oriented innovation and improved performance. Kurniawan, Dzarfan-Othman, Hwang and Gikas (2022) illustrate the role of digital platforms in waste recycling in Indonesia, creating economic incentives and community engagement. Finally, Agrawal et al. (2022) offer a systematic review of CE, digitalization, and business performance, underscoring the importance of customer involvement and product-service systems in advancing CE adoption.

5.2. Cluster Analysis

The co-citation cluster analysis (Figure 5) identifies distinct thematic areas within the literature. The red cluster centers on sustainable business models and product lifecycle management, with influential contributions from Bakker et al. (2020) and Chauhan, Parida and Dhir (2022), who emphasize product durability, reuse, and remanufacturing. The green cluster focuses on digital technologies as enablers of circular practices, highlighting the role of Industry 4.0 tools in improving efficiency and transparency. The blue cluster is linked to consumer behavior and adoption, with papers examining the intention–behavior gap and the role of trust and perceived benefits in driving CE participation. This mapping confirms the multidimensional nature of CE research and underscores the need for integrative frameworks connecting consumers, firms, and digital technologies.

5.2.1. Red Cluster: Circular Economy and Sustainable Business Models

This cluster of papers focuses on foundational and strategic aspects of the circular economy, emphasizing product design, lifecycle management, and the integration of circular principles into business models.

According to Bakker et al. (2020) product life extension is an important way forward to achieving a circular economy through design for durability, reuse, repair, refurbishment, and remanufacture. Chauhan et al (2022) note that adopting circular economy practices requires transforming all aspects of business models, including value creation, capture, and delivery. Sustainable Business Models (SBMs) are often seen as means of achieving a circular economy as they promote the use of renewable resources, reducing waste and pollution, and designing products and services that can be reused, repaired, or recycled (Bocken, 2021; Geissdoerfer et al., 2017).

The integration of Industry 4.0 technologies is accelerating the transition to a circular economy. Chauhan, Sharma and Singh (2021) identified the Internet of Things and cyber-physical systems as critical elements for improving circular economy performance. Furthermore, Chauhan et al. (2022) highlight how emerging technologies such as AI, blockchain, and big data are driving circular economy advancements, enhancing data insights, improving transparency, and enabling more effective decision-making across various sectors.

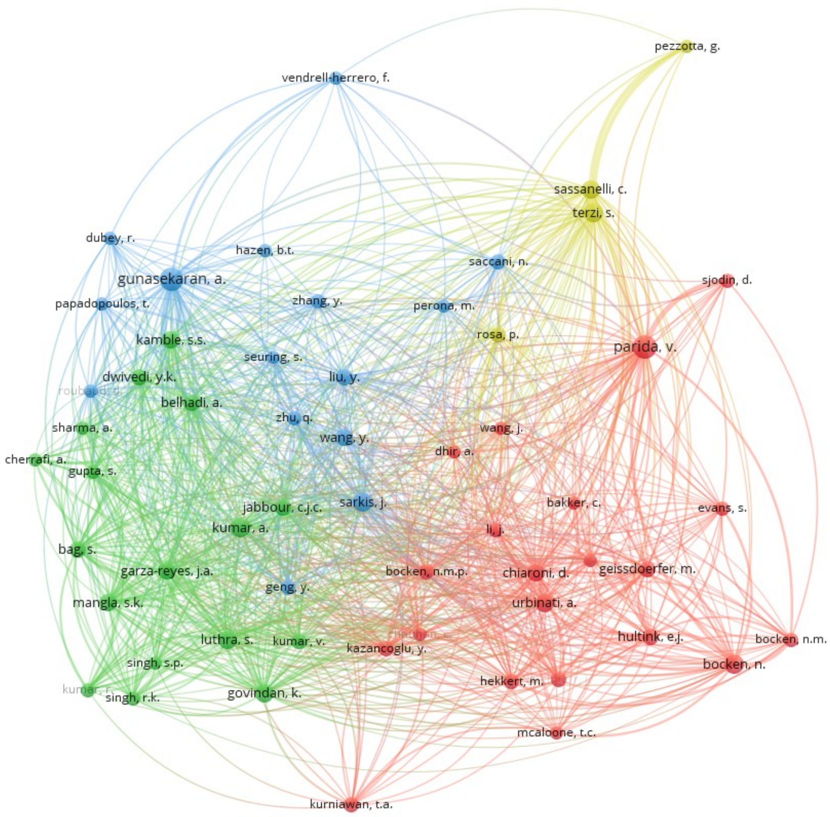

Figure 5. Results of cluster mapping analyzed using co-citations in VOSViewer

However, challenges remain, particularly in consumer behavior. Dhir, Malodia, Awan, Sakashita and Kaur (2021), point out that the severity of the electronic waste crisis is exacerbated by low consumer participation in proper disposal practices. This highlights the need for comprehensive strategies that address not only technological and business aspects but also consumer education and engagement in circular economy initiatives.

5.2.2. Green Cluster: Industry 4.0 and Circular Economy Integration in Smart Manufacturing and Sustainable Supply Chains.

This cluster of papers explores the integration of Industry 4.0 technologies with circular economy principles and sustainable manufacturing, particularly in the context of supply chain management. The research emphasizes the transformative potential of these concepts while also addressing the challenges in their implementation.

A significant theme emerging from the literature is the role of digital technologies in enabling circular economy practices and enhancing supply chain resilience (Bag, Dhamija, Bryde & Singh, 2022; Cherrafi, Chiarini, Belhadi, El-Baz & Chaouni-Benabdellah, 2022; Kamble, Gunasekaran, Ghadge & Raut, 2020). Big data analytics and the Internet of things emerge as crucial components in this technological landscape. Belhadi, Zkik, Cherrafi, Yusof and El-Fezazi (2019) highlight the crucial role of big data analytics in supplying real-time insights into diverse supply chain operations while Gupta, Chen, Hazen, Kaur and Santibañez-Gonzalez (2019) conclude big data analytics enables collaborative, stakeholder-driven circular economy implementation in supply chains for sustainable outcomes and Jabbour, Jabbour, Sarkis and Filho (2019) propose an integrative framework for leveraging large-scale data to unlock new circular economy business models. On the other hand, the Internet of things significantly enhances supply chain efficiency and productivity, offering tangible benefits through improved decision-making, optimized food retail operations, better quality control, effective waste management, and reduced energy consumption (Kamble, Gunasekaran, Parekh & Joshi, 2019).

Industry 4.0, encompassing Smart Manufacturing, Smart Production, and the Internet of Things, is revolutionizing the manufacturing environment through digital and automated technologies that enhance the value chain, leading to reduced lead times, improved product quality, and better organizational performance (Kamble, Gunasekaran & Gawankar, 2018). For instance, Smart Manufacturing Systems (SMS), integrate various technologies like automation, AI, IoT, and cyber-physical systems. These systems offer significant advantages over traditional manufacturing approaches including cost, quality, flexibility, and sustainability (Kamble, Gunasekaran, Ghadge & Raut, 2020).

The cluster also identifies barriers and strategic issues in implementing these advanced concepts. Kamble et al. (2019) identified a lack of government regulations and poor internet infrastructure as barriers to IoT adoption. Kumar et al. (2020) investigate challenges faced by SMEs in applying Industry 4.0 technologies for ethical and sustainable operations, particularly in developing economies. Singh and Kumar, (2020) examine challenges faced by Indian SMEs in supply chain management due to globalization.

5.2.3. Blue Cluster: Green Supply Chain Management and Digital Technologies in the Circular Economy

Green Supply Chain Management (GSCM) integrates environmental considerations into supply chain practices, focusing on environmentally friendly design, manufacturing, sourcing, and distribution (Zhu, Sarkis & Lai, 2008; Zhu & Sarkis, 2004). Dubey, Gunasekaran and Papadopoulos (2017) proposed a comprehensive GSCM framework that combines Knowledge-Based View and Systems Theory, categorizing components and incorporating key dimensions such as Green Intellectual Capital. This holistic approach provides evaluation metrics and guides organizations in enhancing environmental and social performance through sustainable supply chain practices.

Big data analytics has a significant impact on supply chain and organizational performance (Dubey, Gunasekaran, Childe, Papadopoulos, Luo, Wamba et al., 2019). Gunasekaran, Papadopoulos, Dubey, Wamba, Childe, Hazen et al. (2017) identified a three-stage process (acceptance, routinization, and assimilation) for big data analytics assimilation, influenced by resources and top management commitment. Dubey et al. (2019) further demonstrated that big data and predictive analytics significantly impact social and environmental performance in supply chains.

Implementing circular economy principles in supply chains requires consideration of both technological and behavioral aspects. Hazen, Overstreet and Cegielski (2012) developed a comprehensive framework for understanding and implementing post-adoption stages of supply chain innovation. Furthermore, Hazen, Mollenkopf and Wang (2017) found that consumer attitudes toward remanufactured products are important moderating factors in predicting consumer switching behavior to remanufactured products.

Wang et al. (2020) examined how information about remanufacturing processes influences consumer intentions to switch from new to remanufactured products. They found that product history and remarket process knowledge positively impact attitudes and switching intentions, while recapturing process information reduces switching intention. However, the practical significance of these informational factors is low, suggesting that other elements may be more influential in shaping consumer behavior in circular economies.

5.2.4. Yellow Cluster: Product-Service Systems Design in the Circular Economy

This cluster addresses the integration of product and service design within the circular economy, emphasizing the role of engineering and technology in developing product-service systems. By integrating digital technologies, data analytics, automation, and connectivity into circular business models and practices, companies can enhance resource efficiency, lifecycle management, supply chain operations, and customer engagement within the Circular Economy framework (Rosa, Sassanelli, Urbinati, Chiaroni & Terzi, 2019).

A product-service system (PSS) is a business model that combines products and services to meet customer needs, offering benefits such as diverse choices, maintenance services, and personalization while promoting environmentally conscious consumption (Mont, 2002).

Effective PSS development requires a dual focus on customer perspectives and company performance (Pezzotta, Sassanelli, Pirola, Sala, Rossi, Fotia et al., 2018). From the company's perspective, a key challenge in PSS design is integrating service features during product development. To address this, Design for X (DfX) approaches are being adapted to enhance service functionalities and support circular economy principles (Sassanelli, Urbinati, Rosa, Chiaroni & Terzi, 2020). From the customer perspective, co-creation, involving active customer and stakeholder participation throughout the product-service lifecycle, is emphasized as a means to gain insights, tailor offerings, and foster innovation (Pezzotta, Cavalieri & Romero, 2017).

5.3. Main Characteristics and Results of the Circular Economy, Consumer, and Digital Technologies

Despite their valuable insights, most reviews fail to explicitly focus on the consumer's role, a crucial aspect of the circular economy paradigm. In our examination, we scrutinized the contributions, circular approaches analyzed, digital technologies explored, perspectives on consumer involvement, and recommendations for future research, as summarized in Table 7.

The literature highlights that product-service systems and servitization (Agrawal et al., 2021; Agrawal et al., 2022; Atif, 2023) are increasingly enabled by IoT, AI, and smart contracts, creating sustainable offerings where consumer participation is central. Other studies stress consumers' influence on manufacturing adoption of CE practices through real-time data (Awan, Sroufe & Shahbaz, 2021), the role of digital technologies in mass personalization and improved customer experiences (Chauhan et al., 2022), and blockchain-driven incentives for recycling and responsible consumption (Gebhardt et al., 2022; Rejeb, Suhaiza, Rejeb, Seuring & Treiblmaier, 2022). Research on remanufacturing and product returns (Kerin & Pham, 2019; Ritola, Krikke & Caniëls, 2020) shows how IoT, AR/VR, and data mining capture consumer use patterns to extend product lifecycles. More recent contributions emphasize digital platforms, deep learning, and ethical considerations (One Planet Network, 2023; Sánchez-García et al., 2024; Toth-Peter et al., 2023), which empower consumers with transparent product information and opportunities to engage in sustainable behaviors.

Authors	CE	Technology	Consumer
Agrawal et al. (2021), Agrawal et al. (2022)	Product-service-system	Industry 4.0 technologies, smart manufacturing, intelligent product-service systems, digital factory, smart factory, cloud manufacturing, cyber-physical systems	Findings indicate that digital tools are key enablers for creating sustainable products in a circular economy. The research emphasizes the critical role of customer participation in leveraging digital technologies to innovate circular, sustainable offerings. To accelerate the adoption of both circular economy principles and digital solutions, the study recommends shifting towards product-service systems.
Atif (2023)	Product-service-systems Servitisation	IoT, AI, Smart contracts	Industry 4.0-driven platforms enable customer-oriented Product-Service Systems (PSS), enhancing value proposition, loyalty, and market value in circular economies.
Awan et al. (2021)	Resource reuse, remanufacturing, recycling, and reducing waste through closed-loop systems	IoT, big data, and robotics	The article underscores consumers' influence on manufacturing firms' adoption of circular economy practices, highlighting the importance of meeting consumer demands and leveraging IoT for real-time usage data.
Chauhan et al. (2022)	Business model innovation (CBMs and PSS)	Big Data, Artificial Intelligence, Internet of Things, Blockchain	Digital technologies enable mass personalization, meeting 'green segment' demands, enhancing customer experience, and reducing waste.
Gebhardt et al. (2022)	Circular Supply Chain	Digital Twins, AI, Internet of Things, Blockchain, and Cloud Systems	(1) Technology for product development and optimization enabling collaboration between consumers and manufacturers. (2) Smart contracts for personalized discounts, (3) blockchain tokenization to incentivize recycling, and (4) sensor data sharing for enhanced consumer decision-making and product longevity.

Authors	CE	Technology	Consumer
Kerin and Pham (2019)	Remanufacturing	Internet of Things (IoT), Virtual Reality (VR) and Augmented Reality (AR)	(1) Among the primary applications of the Internet of Things (IoT) and Industry 4.0 technologies is predictive maintenance. (2) The consumer plays a central role in remanufacturing: engaging with QR-coded WEEE products post-use, influencing MoL reconfiguration via digital twins, and shaping remanufacturing according to their expectations.
One Planet Network (2023)	Rethinking, Extending, and reusing	IOT, AR /VR. Digital platforms and marketplaces, AI and ML	Highlights how IoT, AR/VR, digital platforms, and AI/ML can empower consumers to make informed decisions, participate in sustainable practices, and adopt circular consumption patterns.
Rejeb et al. (2022)	1. Product recovery (reuse, remanufacturing, recycling) 2. Servitization 3. CE levers support (Circular Business Models and inter-industry cooperation)	RFID, Big data, Blockchain, AI, CPS, Augmented reality (AR), Cloud computing, Virtual reality (VR), 3D printing, 5G	(1) IoT enables businesses to develop a forward-thinking approach that integrates user patterns into the creation of new products. This strategy fosters circular product lifecycles, enhances customer contentment, and contributes to overall well-being. (2) The technology can also improve the customer experience and foster brand loyalty.
Ritola et al. (2020)	Product returns	Data mining techniques Big data analytics RFID (Radio Frequency Identification)	Product returns offer valuable insights into the use of a product by its end customer, providing essential information for firms to derive insights specific to their situation.
Sánchez-García et al. (2024)	Community and technology integration, ethical considerations, technological synergies, sustainable business models, and the burgeoning bioeconomy.	Deep learning, big data, AI, IoT and Blockchain	Certainly! Here's the paraphrased text: (1) Using blockchain technology, products can be tracked securely and transparently, which helps to build consumer trust. (2) The integration of Industry 4.0 in the circular economy could drastically change how consumers engage with products. (3) Digital transformation empowers consumers with reliable information regarding the sustainability of their purchases. (4) The ability to trace products can impact consumer behavior, potentially leading to more sustainable choices.
Toth-Peter et al, (2023)	Circular Business Models: *Reverse flows *Circular design *Consumers and users *Collaborations *Product lifecycle management *Service-based models	Blockchain, Internet of Things (IoT), big data and cloud data, artificial Intelligence (AI), Augmented Reality (AR) and Virtual Reality (VR), advanced robotics and autonomous systems	The article emphasizes consumer involvement in design, utilizing big data for efficient monitoring, blockchain for control, and IoT for customized solutions, promoting circular economy principles through service-based models.

Table 7. Review studies related to CE and digitalization and their views on the consumer

This subsection presents the following results: the main characteristics when CE, CB, and DT are studied (Subsection 5.2.1) and Digital technologies for circular economy in each consumer and CE approach (Subsection 5.2.2).

5.3.1. Characteristics of the Circular Consumer and Digital Technologies

Rodríguez-Espíndola et al. (2022) identified customer pressure, governmental pressure, and market uncertainty as key factors impacting CE and technology adoption. Further research by Khan, Ahmad, Sheikh and Yu (2023), found that customer pressure has a significant and positive influence on the relationships between green technology adoption, circular economy principles, and sustainable supply chain management practices.

In today´s dynamic marketplace, consumer preferences are shifting towards sustainability, with a rising demand for products and services that align with CE principles (Sajjad, Zhang, Asmi, Anwar & Bhatia, 2024). Concurrently, there is a growing inclination towards experiential transactions among consumers, particularly favoring personalized experiences (Gavrila & de-Lucas-Ancillo, 2021) and technology-based businesses. This trend is particularly evident among younger generations, such as millennials, who prefer rental or pay-per-use models and are keenly interested in understanding raw materials' production processes and origins (Gavrila & de-Lucas-Ancillo, 2021). For example, recent research by Bigerna, Micheli and Polinori (2021) highlights the active pursuit of environmentally friendly smartphones among university students, showcasing a significant willingness to pay for devices certified with ecolabels indicating durability and repairability characteristics.

Despite the advancements, challenges persist in understanding consumer behavior and attitudes toward Sustainable Business Models (SBMs) (Sharma & Sijariya, 2023). Integrating CE principles with Industry 4.0 technologies Product-Service Systems (PSS) poses risks due to uncertainties surrounding consumer acceptance and willingness to pay (Atif, 2023). Consumer knowledge, awareness, and perception of CE are the primary barriers to adopting CE models from a consumer perspective. These barriers significantly impact marketing efforts, with approximately 73% of marketing challenges attributed to them (Ada, Sagnak, Uzel & Balcıoğlu, 2022). However, technologies have demonstrated the potential to enhance competitiveness, consequently influencing customer perceptions and satisfaction through advanced technologies and service-oriented approaches (Opazo-Basáez, Vendrell-Herrero, Bustinza, Vaillant & Marić, 2023).

Digital technologies have emerged as instrumental tools in advancing the circular economy agenda. Incorporating innovative and intelligent production technologies intrinsic to Industry 4.0 can enhance circular economy efforts by maintaining products' economic and environmental value throughout their lifecycle (Sajjad et al., 2024). Furthermore, Industry 4.0 technologies facilitate the creation of new knowledge, improvements in production processes, development of competencies, innovation in product and service offerings, and enhancement of customization processes and customer engagement (Bettiol, Capestro, Di-Maria & Micelli, 2022).

Incorporating digital technologies into business operations offers numerous benefits, including enhanced competitiveness, productivity, and innovation in sustainable circular products (Chaudhuri, Subramanian & Dora, 2022). Digital agility is paramount for companies aiming to develop innovative products and maintain a competitive edge by swiftly responding to changing consumer demands and market dynamics (Benabdellah, Zekhnini, Bag, Gupta & Oberoi, 2023). Moreover, digital platforms and shared data facilitated by Industry 4.0 foster stakeholder collaboration, thereby improving communication, coordination, and information sharing (Joshi, Sharma, Luthra, Agarwal & Rathi, 2024). In particular, circular business models such as product-service systems (PSS) exemplify the alignment of consumer requirements with circular economy principles, with digital technologies playing a pivotal role in facilitating CE integration within businesses (Wu & Pi, 2023).

In marketing, CE strategies are pivotal in fostering a better understanding of consumer behavior and attracting and retaining customers. Employing advanced technologies like Industry 4.0 tools, such as sensors, data analytics, and machine learning algorithms, enhances process efficiency, quality, and responsiveness to customer needs (Skalli, Charkaoui, Cherrafi, Shokri, Garza-Reyes & Antony, 2023). These technologies facilitate a deeper understanding of customer behavior (Akbari, 2023) empowering decision-makers to make informed choices (Atif, 2023).

Industry 4.0 technologies, including the Internet of Things (IoT) and big data analytics, enable businesses to track consumer behavior and provide tailored services. Leveraging consumer preferences and usage patterns, data allows companies to offer personalized and sustainable solutions that resonate with environmentally conscious consumers (Toth-Peter et al., 2023). Customization entails selecting from pre-designed products, while personalization involves customer participation in the product development process, leading to heightened user experience and engagement (Aheleroff, Philip, Zhong & Xu, 2019).

Furthermore, with business analytics and intelligence, enterprises offer personalized advice to optimize product usage, extending their lifespan (Ertz et al., 2022). Additionally, customers play a pivotal role in driving the adoption, success, and sustainability of AI-enabled circular business models in digital servitization by providing input, co-creating solutions, and offering feedback for improvement, thereby ensuring alignment of value delivery processes (Sjödin, Parida & Kohtamäki, 2023).

Data adds value by driving transparency, optimization, learning, and understanding customer needs (Luoma, Rauter, Penttinen & Toppinen, 2023). Managers can analyze customer data on age, usage, trust, satisfaction, and financial value to predict subscription intentions and improve offerings and marketing strategies. At the same time, data can add value by driving transparency, optimization, learning, and a deeper understanding of such factors as customers (Sharma & Sijariya, 2023).

Leveraging digital connectivity emerges as a pivotal factor, enabling companies to enrich customer interactions, elevating value propositions, and positively influence customers' willingness to pay for subscriptions (Sharma & Sijariya, 2023). Moreover, using these technologies facilitates real-time monitoring, enables better decision-making, and ensures rapid responses to quality issues, enhancing overall customer satisfaction (Skalli et al., 2023). Product-Service Systems (PSS) are identified as instrumental in cultivating customer loyalty among existing consumers while attracting new customers to the market (Atif, 2023). Additionally, companies stand to benefit from information exchange facilitated by digital platforms, resulting in extended product life, enhanced customer engagement, cost savings, revenue generation, and the establishment of a sustainable brand image (Jørgensen & Scarso, 2023). The adoption and assessment of AI-enabled products and services are expected to remain central in driving customer value and shaping the future landscape of technological forecasting and social change (Dwivedi et al., 2023).

5.3.2. Digital Technologies for Circular Economy in Each Consumer and CE Approach

Table 8 provides an overview of eight digital technologies (artificial intelligence, internet of things, big data and analytics, 3D printing, blockchain, augmented reality, virtual reality, and digital platforms) and their roles in each consumer role identified in the literature review: customer, user and EOL product holder according to (Shevchenko et al., 2023).

Approach 1, related to the consumer as a customer (Purchase stage), considers technologies like AI, IoT, Big Data Analytics, 3D Printing, Blockchain, Augmented Reality, Virtual Reality, and Digital Platforms to enable mass personalization, informed decision-making, sustainable purchasing practices, customer-centric solutions, efficient product personalization, and customization. They also promote trust, transparency, traceability, and consumer engagement in green behaviors, contributing to a more sustainable and efficient circular economy (Chaudhuri et al., 2022; Chauhan et al., 2022; Rejeb et al., 2022; Sánchez-García et al., 2024; Toth-Peter et al., 2023).

Then, Approach 2 is dedicated to the consumer as a user (Usage stage). Integrating AI, IoT, and BDA in this stage extends product lifespan by providing customized solutions and enhancing maintenance and repair services. AI enables personalized experiences, IoT offers real-time insights, and BDA informs decision-making for reuse and maintenance. Additionally, Blockchain ensures traceability and facilitates peer-to-peer transactions, while digital platforms facilitate product refurbishing through informative notifications and reminders (Chaudhuri et al., 2022; Jørgensen & Scarso, 2023; Mukhopadhyay, Singh & Jain, 2024; Rejeb et al., 2022).

Finally, Approach 3, focused on the consumer as an EOL product holder (Disposal stage), presents Digital technologies such as Big Data Analytics (BDA), Additive Manufacturing, and Artificial Intelligence (AI) as vital in improving efficiency throughout the reverse logistics supply chain. They enable better waste sorting, tracking, and forecasting, increasing material recovery and reducing waste (Kurniawan et al., 2022; Sánchez-García et al., 2024). AI facilitates tracking, monitoring, and managing End-of-Life (EOL) products, promoting circularity and sustainability. Additionally, IoT devices gather real-time data on waste management processes, aiding in informed decision-making. Blockchain systems incentivize recycling and ensure transparent waste transactions Apps and online platforms encourage recycling and facilitate material exchange between waste generators, recyclers, and consumers, promoting a more efficient and transparent recycling ecosystem. Robotics and automation technologies enhance waste sorting accuracy and speed in recycling facilities, resulting in higher recycling rates. These digital transformations offer social benefits by informing consumers, facilitating waste separation, and promoting sustainable practices in the circular economy (Kurniawan et al., 2022).

Digital Technology	Consumer role			References
	Purchaser	User	EOL product holder	
Artificial Intelligence	*AI facilitates personalized mass production based on individual consumer needs. *AI assists purchasers in making informed decisions through data-driven insights and analysis. *AI supports purchasers in discovering new value propositions and opportunities within the circular economy, promoting more sustainable purchasing practices and choices.	*AI enables customized solutions based on user preferences and behavior, enhancing user experience and satisfaction *AI-driven solutions continuously learn from user interactions and feedback for continuous improvement in performance, usability, and relevance over time *Users benefit from AI-generated insights and recommendations for optimizing operations, processes, and interactions with products and services	*AI can facilitate tracking, monitoring, and managing of EOL products to promote circularity and sustainability. *AI can help EOL product holders extract maximum value from returned products by enabling efficient refurbishment, recycling, and reintegration into the value chain. *AI can provide customers with recommendations for proper waste disposal by analyzing visual waste data. *Automated sorting of recyclable materials	Chauhan et al. (2022), Kurniawan et al. (2022), Liu et al. (2022), Rejeb et al. (2022), Sjödin et al. (2023)
Internet of things	*Meeting the needs of customers in the 'green' segment. *Enhances customer satisfaction by aligning products with needs * Facilitates tailored customer-centric solutions powered by sensor technology	*IoT improves consumer experience by offering real-time info on product usage, personalized settings, and informed decision-making on the repair. *Enables condition-based maintenance *Personalized advice to enhance product usage for an extended lifespan.	*IoT devices collect real-time data on waste management processes, such as collection, sorting, and recycling. *Enables product tracking and informed decision-making on recycling. * Connects diverse components into an integrated system, including intelligent waste containers, facilities for recycling, and mobile applications for individual waste management.	Chauhan et al. (2022), Kurniawan et al. (2022), Rejeb et al. (2022), Sánchez-García et al. (2024), Toth-Peter et al. (2023)
Big Data and Analytics	*Empower stakeholders in the circular economy to make choices based on reliable information *Enhance brand image *Forecast the need for particular products, helping to balance supply and prevent both shortages and excess.	*Improving decision-making for reusing, remanufacturing, and recycling. *Support the extension of product life by creating predictive maintenance criteria.	This helps in identifying patterns and trends in the waste-generating process. Product returns reveal customer usage patterns, offering firms valuable business insights.	Bressanelli et al. (2022), Chauhan et al. (2022), Kurniawan et al. (2022), Mukhopadhyay et al. (2024), Rejeb et al. (2022), Ritola et al. (2020), Sánchez-García et al. (2024), Kerin & Pham. (2019)

Digital Technology	Consumer role			References
	Purchaser	User	EOL product holder	
3D Printing	*Customizing items to extend their usable lifespan *Swiftly and effectively addressing client requirements *Involving users in the design process to decrease environmental impact *Allows for on-demand production *3D printing enables customization and localized production, allowing for the creation of unique, tailor-made products that meet specific consumer needs *Decentralized manufacturing through 3D printing can decrease carbon emissions from shipping and lower energy use linked to extended logistics networks	On-demand production of spare parts for repair and upgrades	3D printing can utilize recycled materials such as feedstock, turning waste, plastics or other materials into new products	Bressanelli et al. (2022), Chaudhuri et al. (2022), Rejeb et al. (2022)
Blockchain	*Trust, transparency, traceability, security and reliability. *Encourage consumer green behavior *Automated transactions *Blockchain can track the lifecycle of products, from sourcing raw materials to manufacturing, use, and eventual recycling or disposal, ensuring transparency and accountability at every stage *Blockchain can be used to verify the authenticity and provenance of products, materials, and components in the circular economy, helping to combat counterfeiting and greenwashing practices	*Monitors and controls usage *Blockchain offers a platform for conducting peer-to-peer transactions without any third-party intermediaries.	*Consumers can earn digital tokens for recycling products through blockchain-based systems. *Financial investigation *Used to create transparent and secure digital records of waste transactions, ensuring the traceability and authenticity of recycled materials.	Bressanelli et al. (2022), Chaudhuri et al. (2022), Chauhan et al. (2022), Jain et al. (2022), Kurniawan et al. (2022), Rejeb et al. (2022), Sánchez-García et al. (2024), Tot-Peter et al. (2023)
Augmented Reality	*Enable the tracking of products' environmental impact. *Willingness of consumers to engage in augmented reality-based CE systems	*Remote assistance and guidance for maintenance activities *Video guides provide visual demonstrations of maintenance tasks and repair procedures		Bressanelli et al. (2022), Rejeb et al. (2022)

Digital Technology	Consumer role			References
	Purchaser	User	EOL product holder	
Virtual Reality	*Enable product customization *Support decision-making concerning circular product design *Impact of virtual reality on customer perceptions of circular products			Rejeb et al. (2022)
Digital Platforms	Serve as collaboration platforms, engaging consumers in CE practices. Mobile applications to gamify sustainable living	Facilitate the refurbishing of products	*Apps that encourage recycling *Online platforms and mobile applications are developed to connect waste generators, recyclers, and consumers, facilitating the exchange and recycling of materials more efficiently and transparently.	Kurniawan et al. (2022), Sánchez-García et al. (2024)
Other technologies		*Email notifications, text messages, and reminders offer users valuable information on product maintenance schedules and care tips.	Robotics and automation technologies are implemented in waste sorting facilities to improve the speed and accuracy of sorting processes, leading to higher recycling rates.	Jørgensen and Scarso (2023), Kurniawan et al. (2022)

Table 8. Matrix of the relationships between CE, consumer, and digital technologies

5.4. Main Characteristics and Results of the Circular Economy, Consumer, and Digital Technologies

Most studies reviewed focused on identifying the factors that connect digital technologies to the consumer (see Figure 6). These factors fall into six major themes: digital technologies, company, marketing, DT benefits for consumers, consumers in the CE, and customer performance.

- Digital technologies: The main technologies identified in the literature review as relevant in the circular economy adoption by consumers include the internet of things, artificial intelligence, big data, augmented reality, virtual reality, 3D printing, blockchain, robotics, and mobile apps (Bressanelli et al., 2022; Chaudhuri et al., 2022; Chauhan et al., 2022; Jain et al., 2022; Jørgensen & Scarso, 2023; Kurniawan et al., 2022; Liu et al., 2022; Mukhopadhyay et al., 2024; Rejeb et al., 2022; Sánchez-García et al., 2024; Sjödin et al., 2023; Toth-Peter et al., 2023). The details about the use of each of these technologies in the various roles of consumers in the circular economy are elaborated in Table 8 and summarized in Table 9.
- Company: Digital technologies facilitate resource optimization, support circular business models, enhance supply chain transparency, and foster collaboration and innovation (Cagno et al., 2021). Looking ahead, the adoption of circular economy principles is expected to enhance enterprises' competitive advantage (Chi et al., 2023) and the establishment of a sustainable brand image (Jørgensen & Scarso, 2023). Additionally, digital transformation can accelerate the company's shift towards resource-efficient and circular production systems by driving disruptive innovations, new business models, and novel collaborations (Neligan, Baumgartner, Geissdoerfer & Schöggl, 2023).
- Marketing: Digital technologies in the circular economy context enable businesses to better understand consumer behavior, attract and retain customers, provide customization, and predict customer intentions. Advanced technologies like Industry 4.0 tools, including sensors, data analytics, and machine learning

algorithms, enhance process efficiency and responsiveness to customer needs (Skalli et al., 2023). These technologies facilitate a deeper understanding of customer behavior (Akbari, 2023; Atif, 2023). The Internet of Things (IoT) and big data analytics allow businesses to track consumer behavior and provide tailored services, offering personalized and sustainable solutions that resonate with environmentally conscious consumers (Toth-Peter et al., 2023). By analyzing customer data on various factors such as age, usage, trust, satisfaction, and financial value, managers can predict subscription intentions and improve offerings and marketing strategies (Sharma & Sijariya, 2023).

- DT benefits for consumers: Digital technologies in the circular economy enhance convenience, personalization, availability, transparency, predictive maintenance, footprint tracing, and waste sorting. AI and IoT enable mass personalization and provide precise data on product availability and condition (Chauhan et al., 2022). This facilitates predictive maintenance, a leading use case for Industry 4.0 technologies (Kerin & Pham, 2019). Blockchain technology ensures transparency by securely tracking product lifecycles and authenticating sustainability claims (Bressanelli et al., 2022; Kurniawan et al., 2022; Jain et al., 2022; Chauhan et al., 2022; Rejeb et al., 2022; Chaudhuri et al., 2022; Toth-Peter et al., 2023; Sánchez-García et al., 2024). Automation through IoT, AI, and blockchain enhances waste sorting and resource recovery efficiency (Sánchez-García et al., 2024). These technologies also allow consumers to access detailed information about products' ecological footprints, promoting sustainable consumption patterns (Liu et al., 2022). Overall, this data-driven approach optimizes processes, deepens customer understanding, and drives the adoption of circular economy principles (Chi et al., 2023; Sharma & Sijariya, 2023).
- Consumers in the CE: In the circular economy, consumers have three dimensions: customer, user, and EOL product holder (Shevchenko et al., 2023). Customers adopt pro-environmental practices that contribute to reducing the demand for resources in the long term, the consumer as a user (Usage stage): Users are responsible for using and extending the life cycle of products, adopting alternative products like remanufactured and repaired items, and embracing new business models such as renting and reselling and the consumer as an EOL product holder (Disposal stage): EOL product holders minimize waste generation.
- Customer performance: Digital technologies in the circular economy context significantly enhance customer experience and engagement (Chauhan et al., 2022; Rejeb et al., 2022). Customization and personalization strategies lead to improved user satisfaction and deeper engagement (Aheleroff et al., 2019). By leveraging these technologies, businesses gain insights into consumer behavior, enabling personalized services that boost user satisfaction (Chi et al., 2023). The implementation of digital solutions not only improves customer experience but also fosters brand loyalty (Rejeb et al., 2022). Product-Service Systems (PSS) play a crucial role in cultivating customer loyalty and attracting new consumers (Atif, 2023). Notably, technologies like blockchain and IoT enhance transparency and traceability, which builds consumer trust through secure product tracking and support for ethical consumerism (Sánchez-García et al., 2024). This integration of digital technologies in circular economy strategies ultimately leads to enhanced customer experiences, increased trust, improved satisfaction, and strengthened loyalty. Specifically, these technological advancements prioritize customer centricity, enhance organizational data handling, and reduce running expenses by optimizing resource usage and prolonging product durability (Chauhan et al., 2022).

Digital tools empower consumers via online platforms to engage in collaborative consumption and resource circulation. These technologies guide buyers towards eco-friendly choices and encourage their involvement in recycling efforts, both directly and indirectly, thus boosting resource efficiency. For businesses and institutions, such digital solutions enhance consumer insight, refine marketing approaches, and seamlessly align production with consumption patterns (Chi et al., 2023). Moreover, these digital solutions can track consumer habits, allowing organizations to refine their product and service offerings. This data-driven approach enables more efficient equipment usage or replacement, ultimately enhancing customer contentment (Liu et al., 2022; Jabbour et al., 2018).

Digital technologies foster a stronger customer-company bond, promoting shifts away from linear consumption patterns towards more sustainable practices. These tools enable consumers to access detailed information about recyclable goods and their ecological footprint. At the product's end-of-life, users can receive guidance on proper disposal methods. For businesses, this digital connectivity presents opportunities to boost recycling rates through novel services and customer-oriented solutions. These technologies can promote more mindful product usage by tracking item status and user interactions (Liu et al., 2022).

The proposed framework is a result of the literature review that integrates consumer roles within the circular economy, digital technologies, and their benefits for consumers, companies, and performance outcomes. It highlights the results for the customer and how they are built over by the combined efforts of the company, through marketing practices and techniques, company efforts, and digital technologies.

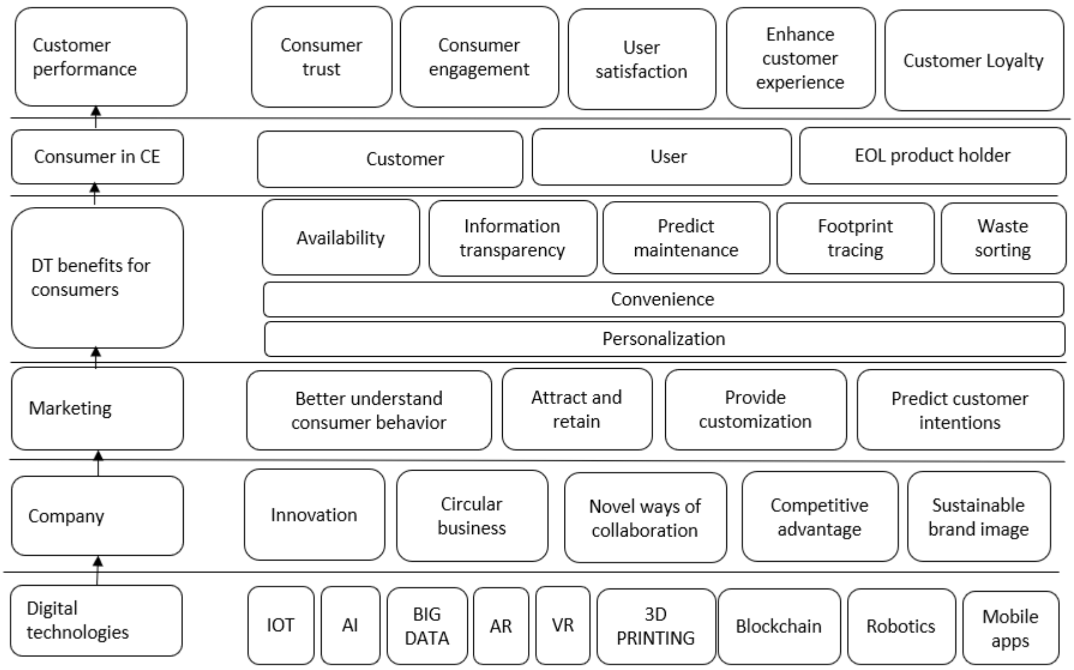

Figure 6. The Digital Circular Behavior (DICEBE) framework for integrating the role of consumer behavior and digitalization in circular economy performance

5.5. Future Research

This subsection discusses the future research agenda based on the review of 55 articles on the integrated view of circular economy principles, consumer behavior, and digital technologies. The following are our recommendations for future studies.

5.5.1. Digital Technologies Integration Across Stakeholders to Drive Collaboration and Customer Satisfaction

To foster collaboration and enhance customer satisfaction, the integration of digital technologies among various stakeholders plays a pivotal role in advancing towards a circular economy. Research on digital servitization and business models underscores the significance of consumers and actors within the broader business ecosystem in driving innovations in circular business models (Bilbao-Ubillos, Camino-Beldarrain, Intxaurburu-Clemente & Velasco-Balmaseda, 2024). For instance, by leveraging digital platforms and shared data, Industry 4.0 facilitates collaboration among stakeholders in the agrifood supply chain, which facilitates improved communication, coordination, and information sharing, allowing companies to respond to disruptions more effectively, meet evolving customer needs, and establish resilient supply chain networks (Joshi et al., 2024).

However, authors have noted significant challenges hindering the application of Industry 4.0 (I4.0) technologies, such as the lack of motivation from partners and customers. Fear of failure of I4.0 technologies is identified as a major challenge affecting stakeholder engagement and adoption (Kumar et al., 2020). Nonetheless, collaboration with AI-enabled systems and partners holds promise for enhancing the ability of end-of-life product holders to manage and optimize the end-of-life phase of products sustainably (Sjödin et al., 2023). For example, the integration of digital technologies and circular economy concepts in logistics enables consumers to return used products, thus promoting a circular supply chain (Agrawal et al., 2022). This integration fosters collaboration across stakeholders and contributes to the realization of circular economy objectives.

5.5.2. Barriers to Consumer Adoption of Digital Technologies in the Context of Circularity

Numerous authors have extensively discussed barriers to implementing circular economy practices within firms. These barriers include consumer awareness and perception (Ada et al., 2022), willingness to engage in circular practices (Arman & Mark-Herbert, 2021), attitudes towards circular products (Hazen et al., 2012; Wang et al., 2020), consumer effort required to engage in sustainable practices (Paparella et al., 2023), consumption work in the circular economy (Hobson, Holmes, Welch, Wheeler & Wieser, 2021), consumer resistance to change due to prevailing linear mindsets (Bressanelli et al., 2022), risk of counterfeiting and authenticity of the products (Jain et al., 2022) and the fact that only 20% of consumers believe that they can personally have an impact on environmental sustainability (Boston Consulting Group, 2022).

Table 9 presents the barriers to circular consumption encountered by each consumer role. It also includes the corresponding digital technology solutions designed to address these barriers, summarizing the content of Table 8.

Barriers to Circular Consumption			
Customer	**User**	**End-of-life product holder**	**Authors**
*Knowledge and awareness about CE *Perception towards CE *Concerns about product quality	*Resistance to extending product lifespan *Lack of access to repair services *Preference for convenience over sustainability	*Lack of awareness about proper disposal	Ada et al. (2022), Arman and Mark-Herbert (2021), Bressanelli et al. (2022), Hazen, Overstreet, Jones-Farmer et al. (2012), Hobson et al. (2021), Jain et al. (2022), Paparella et al. (2023), Wang et al. (2020).
Digital technologies solutions			
AI: Personalized mass production, informed decision-making, sustainable purchasing. **IoT:** Meets 'green segment' demand, enhances satisfaction, and offers customized solutions. **Big Data:** Informed decisions and enhances brand image. **3D Printing:** Product personalization, responding to needs, integrating consumers. **Blockchain:** Promotes trust and transparency and encourages green behavior. **AR:** Traces environmental footprint and engages consumers. **Digital Platforms:** Collaborative engages consumers in circular practices.	**AI:** Customized solutions, continuous learning, operation optimization. **IoT:** Improves experience, enables maintenance, and offers usage advice. **Big Data:** Informs reuse and extends product life. **3D Printing:** On-demand parts, uses recycled materials. **Blockchain:** Monitors usage, facilitates transactions, and ensures transparency. **AR:** Assists maintenance and provides guidance. **Digital Platforms:** Facilitates refurbishing and encourages recycling.	**AI:** Tracks and manages EOL products, extracts value, advises disposal, and automates sorting. **IoT:** Collects waste data, tracks, and aids recycling decisions. **Big Data:** Identifies waste trends. **3D Printing:** Uses recycled materials and provides spare parts. **Blockchain:** Records waste transactions transparently.	Bressanelli et al. (2022), Chaudhuri et al. (2022), Chauhan et al. (2022), Jain et al. (2022), Jørgensen and Scarso (2023), Kurniawan et al. (2022), Liu et al. (2022), Mukhopadhyay et al. (2024), Rejeb et al. (2022), Sánchez-García et al. (2024), Sjödin et al. (2023), and Toth-Peter et al. (2023).

Table 9. Barriers to CE and DT solutions

The table is organized into barriers for customers and digital technologies solutions and demonstrates how digital technologies can enable and promote circular consumption practices by addressing specific barriers and providing tailored solutions for each stakeholder group.

The organization for customers reflects three moments into the purchase process, being awareness an issue that appears to be transversal. Further investigation into the awareness theme may be required to confirm that hypothesis. Digital technologies point to some trends such as the use of AI and data to optimize the process and customization of solutions involved with circular economy practices.

With this approach new barriers appear such as concerns about data privacy in digitalized circular systems (Antikainen et al., 2018) and consumer resistance to digital innovations (Talwar, Talwar, Kaur & Dhir, 2020). Several theories could be used to investigate this issue, but a promising one is the Unified Theory of Acceptance and Use of Technology (UTAUT) model or similar models, exploring advanced technologies (Jain et al., 2022). In particular, the UTAUT framework can provide valuable insights into the factors that influence technology adoption in rapidly evolving technological landscapes. By investigating acceptance and usage behaviors related to cutting preferences. This can lead to the development of tailored strategies and interventions to promote the successful adoption of advanced technologies, ultimately enhancing user experiences and driving innovation in technology acceptance practices.

6. Limitations

This study presents some limitations, as it bases the results exclusively on evidence from existing literature. Although we followed a systematic approach (PRISMA) to minimize bias, the process of selecting studies and interpreting their findings may still be subject to researchers judgment. In addition, literature is constantly evolving, and because digital technologies and the circular economy are rapidly developing fields, any systematic review risks losing relevance over time.

Another limitation is that the analysis relied only on publications indexed in Scopus and Web of Science and restricted to English. Relevant contributions published in other databases, conferences or languages may not have been captured. Moreover, many of the studies analyzed remain conceptual or exploratory, with limited longitudinal or cross-cultural evidence, which restricts the generalizability of conclusions about consumer acceptance and digital enablers.

Finally, although we combined bibliometric and qualitative synthesis, the coding and clustering steps inevitably involved some degree of subjectivity. As future work, we intend to extend the analysis to practice-oriented reports and real-world contexts. Such empirical extensions would strengthen the robustness of the findings and bridge the gap between academic insights and applied outcomes.

7. Conclusions

This literature review delves into the intersection of circular economy principles, consumer behavior, and digitalization. We proposed The Digital Circular Behavior (Dicebe) framework for integrating the role of consumer behavior and digitalization in circular economy performance and identify a promising research agenda. Our first research question explores the knowledge map on circular economy, consumer behavior, and digitalization. Our findings reveal that circular behavior involves the adoption of pro-environmental practices that reduce the demand for resources in the long term, such as refusing, rethinking, and reducing. It also encompasses responsible product use and extending its life cycle through practices like reusing, repairing, refurbishing, remanufacturing, and repurposing. Additionally, effective reuse of material through recycling and recovery further promotes sustainability.

Regarding the second research question, which asks how circular economy, consumer behavior, and digitalization can be integrated into a theoretical framework, it is worth noting that the digital landscape offers a plethora of tools to enable circularity. From IoT and AI to VR, AR, big data, 3D printing, blockchain, robotics, and digital platforms, these technologies have the potential to drive innovation and support the adoption of circular business models. By utilizing these technologies, companies can foster collaborative partnerships, gain a competitive edge, and enhance their sustainable brand image. Furthermore, these digital tools can help companies better understand consumer behavior, enabling them to personalize offerings and predict customer needs, ultimately leading to increased customer retention.

Digital technologies offer consumers various benefits, such as predicting user demand, ensuring information transparency, facilitating predictive maintenance, enabling footprint tracing and waste sorting, and providing personalized experiences. This enhances consumer trust, engagement, satisfaction, and overall customer experience, increasing customer loyalty to circular brands and products. Consumers assume different roles within this framework, including customers, users, and end-of-life product holders. Their active engagement drives circular consumption behaviors and achieves sustainable outcomes. Furthermore, customer performance metrics such as consumer trust, engagement, user satisfaction, and enhanced customer experience indicate the effectiveness of circular economy initiatives.

This research integrates circular economy, consumer behavior, and digitalization, offering significant academic and practical impacts. Academically, it proposes the Digital Circular Behavior framework and links consumer barriers in the circular economy to potential technological solutions. For businesses and policymakers, the study demonstrates how digital technologies can empower consumers in circular economy initiatives, enhance customer engagement, and foster sustainable business models. Connecting these fields provides valuable insights for both researchers exploring this emerging intersection and practitioners seeking to implement effective circular strategies.

Finally, a few important limitations need to be considered. First, the field of knowledge has only recently emerged; thus, future literature reviews and bibliometric analysis would be useful to examine new related topics that influence consumers' decisions and their willingness to adopt more sustainable behaviors. Besides, research is also needed to determine consumer behavior in current circular business models that offer digital platforms and conventional business models that use digital technologies to transition toward a circular economy.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

Funding

The authors express gratitude to the Doctoral Program in Management of Organizations from the International School of Economic and Administrative Sciences at Universidad de La Sabana for the economic support for the development of his doctoral studies. The authors acknowledge the sponsorship of the Pontificia Universidad Javeriana for the "Circular Motion project; The project aims to design strategic tools to diagnose, implement, and monitor the Circular Economy in Ibero-American companies" ID 00010055 and the Business Sustainability Lab.

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Journal of Industrial Engineering and Management, 2025 (www.jiem.org)