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Driving Sustainable Innovation: A Review of Data-Driven Technologies in Sustainable Business Model Innovation

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ABSTRACT

Many companies use data-driven technologies to drive sustainable business model innovation (BMI), yet often face challenges in doing so effectively. However, the literature at the intersection of data-driven and sustainable BMI remains conceptually dispersed, limiting theoretical progress and practical application. To consolidate the literature, we combine a systematic literature review with bibliometric coupling to conceptualize data-driven sustainable BMI. First, we identify five distinct research streams—digital platforms, circular economy, smart manufacturing and supply chains, blockchain, and servitization—which reflect diverse technological pathways to transform traditional business models into sustainable ones. Second, we develop a dynamic capabilities-based process model that explains how companies can achieve this transformation by orchestrating data-driven and sustainable capabilities across the initiation, ideation, integration, and implementation phases of BMI. This study advances theoretical understanding and provides practical guidance on how data-driven technologies can enable positive environmental, social, and economic outcomes.

1 | Introduction

Data-driven technologies, such as the Internet of Things (IoT), artificial intelligence (AI), data analytics, and blockchain can contribute to sustainable business practices. In particular, digital transformation—adopting digital technologies for business model development (Verhoef et al. 2021)—can help close material and energy loops and support efforts in recycling, reusing, and remanufacturing (Langley 2022; Murray et al. 2017). Recent studies show that AI-based technologies, including generative AI, drive sustainability, particularly by accelerating social outcomes (Torrent-Sellens et al. 2025) and enhancing exploitative and exploratory learning processes to advance sustainability in production systems (Wang and Zhang 2025). In doing so, sustainable business and management practices can address significant environmental and social challenges (Atif et al. 2021) and contribute to achieving the United Nations' Sustainable Development Goals (SDGs) (Dantas et al. 2021; Mahajan et al. 2024).

Companies use data-driven technologies to foster sustainable business model innovation, such as through smart manufacturing (González-Varona et al. 2020) and digital servitization (Paiola et al. 2021). Two examples highlight the potential of business model innovation (Centobelli et al. 2020). First, in the apparel industry, the IoT and AI have improved sustainability by facilitating resource monitoring and real-time tracking via RFID systems. These technologies allow companies to trace products throughout the supply chain, authenticate products, and verify their supply chains (Abbate et al. 2023). Second, a ceramic tile manufacturer (García-Muiña et al. 2018) implemented data-driven technologies, such as the IoT, to transition from a linear to a circular business model. The IoT was used to collect, store, and process data for impact assessment and real-time monitoring of performance and operational flows, such as resource usage. This helped the company overcome difficulties in data management, optimize production processes, and enhance the sustainability of its operations.

These examples demonstrate that the successful implementation of data-driven sustainable business model innovation requires companies to operate differently than before. Hence, adopting a capabilities-based perspective is valuable for analyzing the drivers of such strategies.

Several reviews explore the topic of digital sustainability (see Table 1), highlighting how digital technologies enable circular (Chauhan et al. 2022; Khan, Shah, et al. 2022; Liu, Quddoos, et al. 2022) and sustainable business models (Holzmann and Gregori 2023). Some studies focus on specific technologies, such as Industry 4.0 (Toth-Peter et al. 2023), AI (Di Vaio et al. 2020; Madanaguli et al. 2024), and information technologies (Vidmar et al. 2021), as enablers of these business models. Others examine digitalization and sustainability as drivers of new business models (Capurro et al. 2024) or adopt a strategic management perspective on digitally enabled sustainable business models (Palmié et al. 2024).

However, none of these reviews examine the intersection of data-driven technologies and sustainable business model innovation from a dynamic capabilities-based perspective. Such a perspective is urgently needed (Palmié et al. 2024). First, from a researcher's perspective, there is a research gap in understanding how integrating data-driven technologies into the innovation process can foster the development of sustainable business models. Second, from a practitioner's perspective, there is a need to identify the specific data-driven and sustainable capabilities that can promote environmentally, socially, and economically sustainable development.

TABLE 1 | Overview of review articles on digital technologies enabling sustainability-oriented business models.

Study	Method, sample size	Focus area	Identified gaps
Chauhan et al. (2022)	SLR, $N=123$	Digital technologies as an enabler of circular BMs	Does not adopt a DCs perspective
Khan, Shah, et al. (2022)	SLR, $N=91$	Digital technologies as an enabler of circular BMs	Does not examine BMI dynamics; capabilities are briefly mentioned, but not discussed within a DCs perspective
Liu, Trevisan, et al. (2022)	SLR, $N=174$	Digital technologies as an enabler of circular BMs	Does not examine BMI dynamics or adopt a DCs perspective
Holzmann and Gregori (2023)	SLR, $N=59$	Digital technologies as an enabler of sustainable BMs	Does not examine BMI dynamics or adopt a DCs perspective
Toth-Peter et al. (2023)	SLR, $N=76$	Industry 4.0 as an enabler of circular BMs	Although the reviewed articles flag DCs as an emerging research stream, DCs are not integrated into the conceptual framework
Di Vaio et al. (2020)	SLR, $N=73$	Artificial Intelligence as an enabler of sustainable BMs	Capabilities are briefly mentioned, but does not adopt a DCs perspective
Madanaguli et al. (2024)	Semi-systematic scoping LR, $N=41$	Artificial Intelligence as an enabler of circular BMs	Focus on AI capabilities, but does not integrate a DCs perspective
Vidmar et al. (2021)	SLR, $N=61$	Information technologies as an enabler of sustainable BMs	Capabilities are briefly mentioned, but does not adopt a DCs perspective
Capurro et al. (2024)	In-depth LR, n/a	Digitalization and sustainability as enablers of new/more innovative BMs	Focuses on boundary resources/capabilities, yet not conceptually linked to DCs theory
Palmié et al. (2024)	Integrative LR, $N=134$	Strategic management perspective on digital-sustainable BMs	Identifies a gap in research on organizational capabilities and calls for future research to explore their role in digital-sustainable BMI

Abbreviations: BM = Business Model, BMI = Business Model Innovation, DCs = Dynamic Capabilities, LR = Literature Review, SLR = Systematic Literature Review.

Accordingly, we derive the following research question: What insights does recent research provide on the process of data-driven sustainable business model innovation that utilizes data-driven technologies for sustainable business model innovation? To address this question, we structured our study around business model innovation, focusing on the intersection of data-driven technologies and sustainability. From this, we developed a process model. First, we conducted a systematic literature review to identify a suitable sample, which we used for bibliographic coupling to determine five clusters representing key research streams. We combined bibliometric coupling with qualitative content analysis to gain deeper insights into these clusters. We found that these can be classified into two primary research streams: digital sustainability and sustainable digital transformation. Our study indicates that companies must possess data-driven and sustainable dynamic capabilities to transform traditional business models into sustainable ones. However, the literature on the dynamic capabilities for data-driven sustainable business model innovation appears conceptually dispersed.

Second, we developed a dynamic capability-based process model that links data-driven and sustainable business model innovations. Our model conceptualizes data-driven sustainable business model innovation and explores how data-driven technologies transform traditional business models into more sustainable ones. In summary, our study contributes to the literature by offering a comprehensive understanding of the role of dynamic capabilities in the process of data-driven sustainable business model innovation.

2 | Conceptual Background

2.1 | Business Model Innovation

A business model is a structural template that guides a company's management and development strategies for its operations (Clauss 2017; Spieth et al. 2014; Teece 2010; Zott and Amit 2013; Zott et al. 2011). The key dimensions of a business model include the following (Gassmann et al. 2015; Latifi et al. 2021): The first dimension, value proposition, expresses the intended added value for the customer through valuable (new) products and services (Latifi et al. 2021; Massa and Tucci 2013). Second, value delivery ensures efficient processes, channel personalization, customer service, and support for target customers. Third, value capture aims to ensure a business's financial success by optimizing revenue streams and cost structures (Johnson et al. 2008). Finally, value creation focuses on maximizing customer-perceived value, meeting customer needs, and minimizing associated risks.

Business model innovation typically involves creating new products and services, introducing new distribution channels, implementing new technologies, and forming new partnerships (de Reuver et al. 2013). It is usually conceptualized as a process divided into four phases: initiation, ideation, integration, and implementation (Frankenberger et al. 2013). During these phases, companies must (1) identify the need to innovate the business model (initiation), (2) collect ideas for the (re)design of the business model (ideation), (3) design a concept for the potential new business model and evaluate it among multiple ideas (integration), and (4) replace the current business model with a new one (implementation) (Bonakdar and Gassmann 2016; Gassmann et al. 2014; Remané et al. 2017).

Business model innovation refers to designing a new business model for startups or reconfiguring an existing business model for incumbents (Massa and Tucci 2013). It is a broad, iterative process (Bachmann and Jodlbauer 2023; Sosna et al. 2010) that involves modifying at least one of the four dimensions during innovation (Baden-Fuller and Haefliger 2013; Baden-Fuller and Mangematin 2013). This process entails recognizing the need for a new business model and redesigning, assessing, and implementing it to create value for the company and its target customers (Teece and Linden 2017). When incumbents use data-driven technologies for business model innovation, they may design and integrate new data-driven business models. This study examines changes within the business models of incumbent companies, focusing on business model reconfiguration. However, throughout this study, we use the term "business model innovation" to draw upon a broader array of literature and integrate diverse insights from various research streams.

2.2 | Sustainability and Sustainable Business Model Innovation

The concept of sustainable business models emerged with Stubbs and Cocklin (2008a), who argue that in these models, social and environmental priorities drive company decision-making. To adopt them successfully, companies must build internal structural and cultural capabilities and collaborate with stakeholders to promote sustainability within the broader socio-economic system (Stubbs and Cocklin 2008b). Sustainable business models differ from traditional ones by considering various environmental, social, and financial needs across various stakeholders (Bocken et al. 2014). Furthermore, sustainable business models integrate sustainability into their value proposition, creation, delivery, and capture mechanisms (Geissdoerfer et al. 2018). A company's dedication to sustainability can indirectly drive innovation in its business model through changes in market dynamics, technology, and entrepreneurial orientation (Klein et al. 2021).

Sustainable business models must balance economic, environmental, and social benefits, thereby contributing to the sustainable development of both companies and society (Boons and Lüdeke-Freund 2013). Company performance is evaluated based on the triple bottom line of social, environmental, and economic value creation (Ekwueme et al. 2013; Hussain et al. 2018). Economic benefits include profit and return on investment, while environmental benefits involve reduced energy consumption and the utilization of renewable resources. In contrast, social benefits encompass community development and labor standards (Evans et al. 2017).

Sustainable business model innovation can be defined as changes in a company's value creation, value delivery, value capture, or value proposition to create positive impacts and reduce adverse environmental and societal effects (Bocken et al. 2014). The innovation process for developing and transforming business models into sustainable ones is complex, because social, environmental, and economic metrics must be incorporated (Laasch 2018). Thus, diverse stakeholders must be included (Freudenreich et al. 2020).

2.3 | Data-Driven Technologies and Data-Driven Business Model Innovation

Data-driven technologies enable the utilization of data and analytics, which are crucial for effective business operations, decision-making, and development (Chen et al. 2012). Advancements in fields, such as the IoT and AI, have made data increasingly important. Thus, business analytics is considered a valuable strategy for transforming a company's business model (Li et al. 2018; Ramaswamy and Ozcan 2016) and creating customer-perceived value (Rashed and Drews 2021). Industry 4.0 (I4.0) allows entirely new business models to create and capture value through digital technologies (Ghobakhloo 2020; Müller and Däschle 2018). Specifically, I4.0 drives data-driven business model innovation by enabling process digitization, smart manufacturing, and connectivity across value networks, reshaping value creation, delivery, and capture (Müller et al. 2018). Data-driven business models use data as a key resource, with data processing and analysis as core activities (Hartmann et al. 2016).

Data-driven business model innovation is defined as either the transformation of a business model into a data-driven business model or the use of data-driven technologies to support the innovation process by analyzing data and converting it into knowledge (Fruhwirth et al. 2020). The main distinction between these two types is that the first necessitates a company integrating data and technology into its business model, such as by altering its products or services. In contrast, the second involves analyzing data to gain insights into customer behavior or market trends and using that knowledge to change the business model.

2.4 | Data-Driven Sustainable Business Model Innovation

We propose the concept of data-driven sustainable business model innovation by exploring the intersection of data-driven technologies, sustainability, and business model innovation (see Figure 1). Data-driven sustainable business model innovation refers to the process of transforming traditional business models into sustainable ones using data-driven technologies such that at least one of the four dimensions (value proposition, value delivery, value capture, and value creation) is changed (Baden-Fuller and Haefliger 2013; Baden-Fuller and Mangematin 2013). The outcome is a sustainable value proposition, sustainable value delivery, sustainable value capture, or sustainable value creation. A business model may also be described as a data-driven business model if at least one of the four dimensions is changed through the business model innovation process to a data-driven value proposition, data-driven value delivery, data-driven value capture, or data-driven value creation. This study focuses on the connection between these

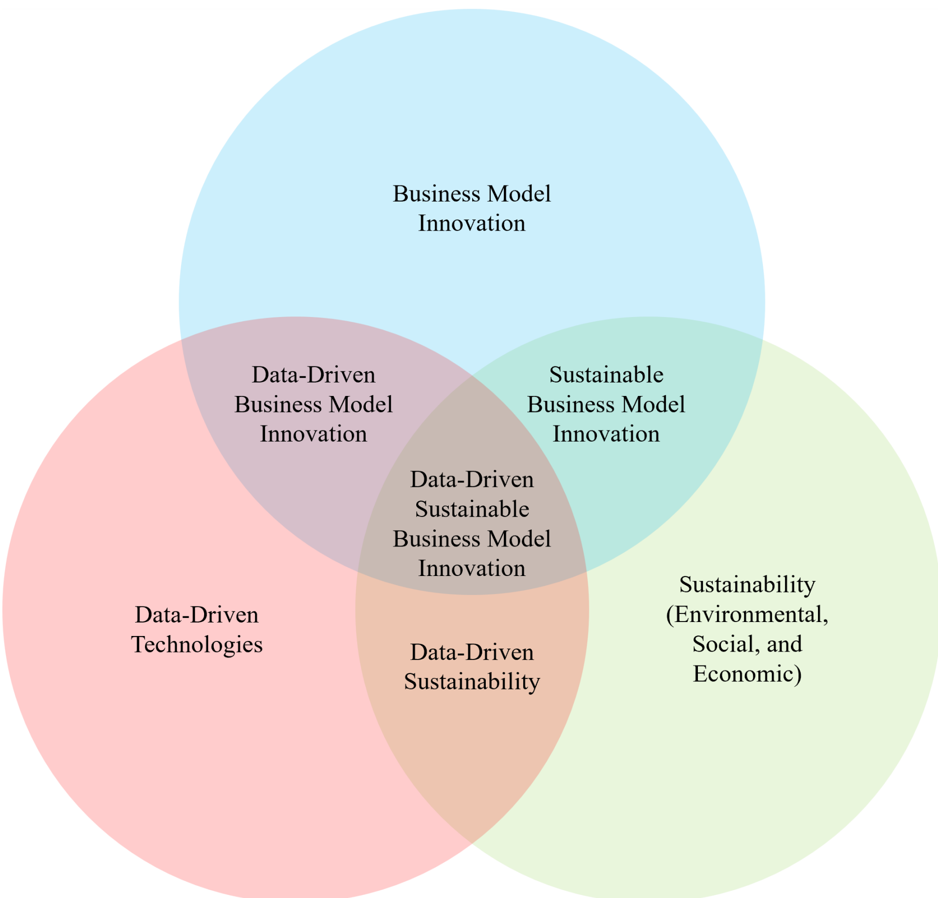

FIGURE 1 | The intersection of business model innovation, sustainability, and data-driven technologies.

two types of business models, namely data-driven sustainable business model innovation.

3 | Methodology

3.1 | Corpus Selection

We conducted a systematic literature review on data-driven sustainable business model innovation, building on the framework proposed by Tranfield et al. (2003), to synthesize the literature and provide a comprehensive understanding of the topic. For this review, we conducted a literature search in the Web of Science (WoS) database in November 2023. We limited our search to WoS because it offers access to a wide range of high-quality journals and is internationally recognized for maintaining rigorous quality standards (Gaviria-Marin et al. 2019). WoS is a well-established source for bibliometric reviews (Zupic and Čater 2014), providing essential metadata (e.g., references and citation counts) (Carvalho et al. 2013), effectively handling lengthy queries (Gusenbauer and Haddaway 2020), and ensuring compatibility with VOSviewer, thereby meeting the needs of this study.

We excluded Scopus due to its high content overlap with WoS (Singh, Singh, et al. 2021). Google Scholar was excluded because its citation data, which are crucial for bibliometric analyses, are often incomplete or inaccurate (Martín-Martín et al. 2018). Our exclusive use of WoS aligns with best practices in bibliometric research, such as Hossain et al. (2024) and López-Concepción et al. (2024).

The literature search comprised three phases: identification, screening, and eligibility, during which various inclusion and exclusion criteria were applied (see Table 2). In the identification phase, articles were required to contain a combination (AND conjunction) of the core terms "business model*" and "sustainab*" with two groups of keywords, either in the title, abstract, or keywords (author keywords and keywords plus).

The first group of keywords refers to "data-driven:"

("data-driven" OR "data-based" OR digital* OR "artificial intelligence-driven" OR "AI-driven" OR "data analytics" OR "machine learning" OR "ML" OR "big data" OR "data mining" OR "data servi*" OR "industry 4.0" OR "I4.0" OR "internet of things" OR "IoT" "industrial internet of things" OR "IIoT" OR blockchain OR "smart product*" OR "smart servi*" OR "digital servi*")

The second group of keywords references "innovation:"

(innovation OR design OR reconfiguration OR creation OR development OR disruption OR invention OR reinvention OR renewal OR transformation OR adaption OR adaptation OR change OR evolution OR revolution OR rethinking)

A criterion for inclusion was to limit the sample to English-language articles. Only peer-reviewed, ranked journal articles were included, as they are recognized as validated sources of knowledge (Podsakoff et al. 2005) and form the basis for the quality appraisal (Aguinis et al. 2020; Hiebl 2021; Kraus et al. 2020). To operationalize the ranking criterion, we used the CABS Academic Journal Guide 2021 and the SCImago Journal Rank 2021, a measure of scholarly journal prestige that accounts for the number of citations a journal receives and the prestige of the citing journals. We set a quality criterion that papers should at least be ranked, as "innovative research ideas may even appear in lower-ranked journals" (Kubíček and Machek 2019, p. 967).

During the first round of eligibility assessment, we included or excluded articles based on their abstracts, titles, and keywords. Articles that mentioned business model innovation,

TABLE 2 | Inclusion and exclusion criteria.

Selection phases	Inclusion criteria	Exclusion criteria
Identification	Articles focusing on business model innovation, sustainability, and data-driven technologies	n/a
	English-language articles	Non-English-language articles
Screening	Journal articles	Conference proceedings, book chapters, and gray literature
	Peer-reviewed, ranked (ABS, SJR) journal articles	Non-peer-reviewed, non-ranked articles
Eligibility	Articles addressing data-driven sustainable business model innovation	Articles that mention business model innovation, sustainability, and data-driven technologies but do not focus specifically on these concepts
	Articles addressing at least one of the three dimensions of sustainability	Articles that do not address any of the three dimensions of sustainability
	Articles addressing business models or business model innovation that incorporate digitalization or digital transformation	Articles addressing business models or business model innovation that do not incorporate digitalization or digital transformation
	Articles addressing business model innovation	Articles addressing only product innovation

sustainability, and data-driven technologies but did not focus specifically on these concepts were excluded. In the second round of eligibility assessment, we conducted full-text reviews to remove articles that did not address data-driven sustainable business model innovation according to our definition. We based our evaluation on the following exclusion criteria: (1) none of the three dimensions of sustainability were addressed; (2) aspects of digitalization or digital transformation were not incorporated into the business model or were not part of the business model's innovation; and (3) only product innovation was addressed, but not business model innovation. Articles meeting any of these exclusion criteria were excluded.

The exclusion of articles focusing solely on product innovation was essential to maintaining alignment with our research focus. Although product innovation can be a precursor to business model innovation, papers that did not examine the resulting changes at the business model level—such as modifications to value creation, delivery, and capture mechanisms—were excluded. By applying these criteria, we ensured that our final sample comprised studies that explicitly examined how technologies drive sustainable business model innovation. In cases where the applicability of these criteria was unclear, the first author screened the literature, while the other authors were involved in discussions to resolve uncertainties.

To ensure the continued relevance and integrity of our sample, we conducted an additional check for article retractions before finalizing the manuscript. During this process, two publications were identified as retracted and subsequently removed from the sample. The final dataset used for analysis thus comprises 131 papers. The article selection process is illustrated in Figure 2.

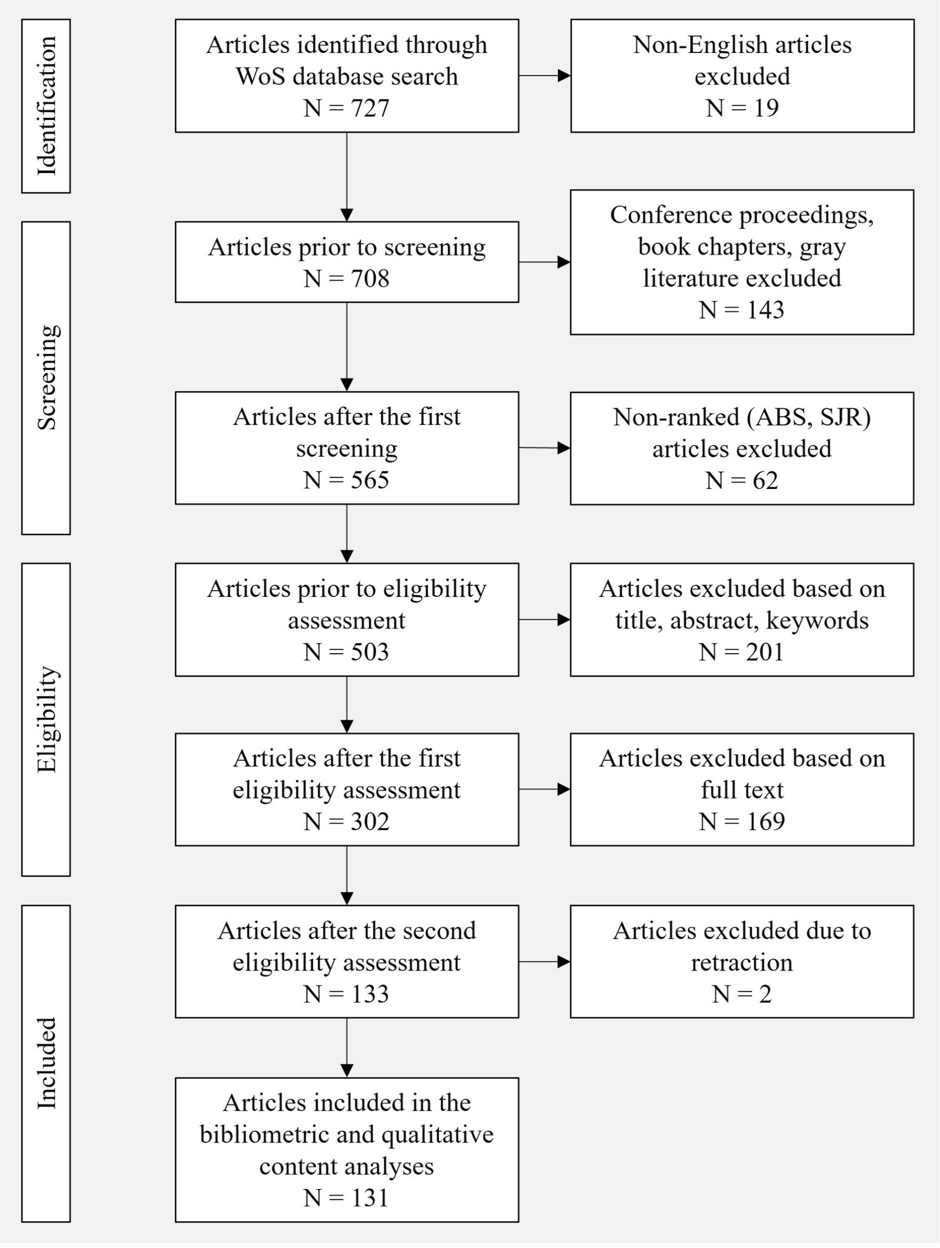

FIGURE 2 | Article selection process.

3.2 | Corpus Analysis

We chose bibliographic coupling as the most appropriate bibliometric analysis technique for mapping the current state of research. Bibliographic coupling can uncover a wide range of topics and their latest developments by forming thematic clusters based on cited publications, allowing new and niche publications to gain visibility (Donthu et al. 2021). To conduct bibliographic coupling (based on documents; minimum number of citations 0) and visualization, we used the bibliometric software VOSviewer.

In bibliographic coupling, the similarity between two articles is measured by the number of shared references; the greater the overlap in their bibliographies, the stronger the linkage and conceptual similarity between them (Zupic and Čater 2014). For instance, if two papers share ten publications in their reference lists, they are linked with a coupling strength of ten (Budler et al. 2021). The total strength of the bibliographic coupling links between each article and others was calculated to identify the most highly connected documents. Documents with similar concepts are positioned closer together on a bibliographic coupling map (Budler et al. 2021). We acknowledge that bibliometric coupling is susceptible to several biases, such as (self)citation, geographical, and accessibility biases, which can impact the accuracy and reliability of the analysis (Zupic and Čater 2014).

Therefore, we combined bibliometric coupling with qualitative analysis to provide deeper insights into the impacts of the included studies, as proposed by Mukherjee et al. (2022). Specifically, the clusters were interpreted using qualitative content analysis (Finfgeld-Connett 2014). First, we reviewed each article to identify relevant data segments and codes (Step 1: Identification of data segments), which we recorded on a spreadsheet (Step 2: Data matrices and coding). We interpreted and synthesized the coded findings across studies and continuously recorded them (Step 3: Memoing). We then compiled a diagram to illustrate the apparent relationship between the codes and accompanying memos (Step 4: Diagramming), which aggregated our findings into a process model for data-driven sustainable business model innovation. We gradually constructed concepts through iterative reflections on ideas and their interconnections (Step 5: Reflection).

4 | Findings

4.1 | Intellectual Structure of Data-Driven Sustainable Business Model Innovation

The bibliographic coupling map (see Figure 3) reveals five clusters, with similar concepts indicated by the close positioning of documents forming each cluster (Budler et al. 2021): (1) digital sustainability and digital platforms (red cluster), (2) digital circular economy (green cluster), (3) smart manufacturing and circular supply chains (blue cluster), (4) blockchain-enabled sustainability (yellow cluster), and (5) smart and circular servitization (purple cluster). Tables A1–A5 provide a detailed listing of all articles assigned to each cluster.

Based on Van Eck and Waltman (2022), we can summarize that on the bibliographic coupling map, two publications that cite the same document are interconnected by a link. Highly linked publications connect related works and are influential within their network. In comparison, highly cited publications are characterized by larger circles, with their sizes corresponding to the number of citations received. Many citations may indicate foundational publications with a greater influence on the field. By contrast, less frequently cited publications suggest more specialized contributions. If two publications cite many of the same sources, they are more strongly related and are located closer together on the bibliographic coupling map. Greater distances between publications indicate weaker connections. These clusters consist of related publications. If two clusters are close to each other, they are

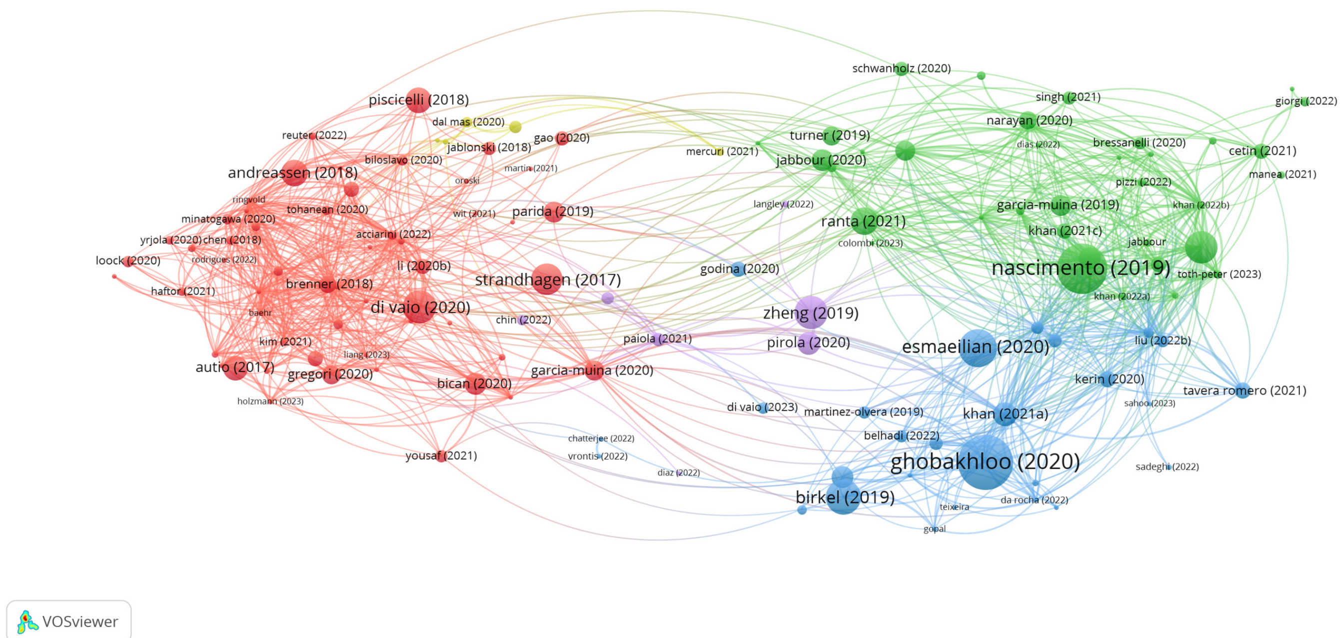

FIGURE 3 | Bibliographic coupling performed by VOSviewer.

thematically related, as the publications within them cite some of the same sources. A greater distance between clusters suggests thematic separation.

4.1.1 | Digital Sustainability and Digital Platforms

Within the largest cluster (55 items), shown in red on the left side of the figure, most publications are closely positioned, indicating a shared focus on digital sustainability and digital platforms. This cluster primarily centers around Brenner (2018), who, with 113 links, connects related publications at its center, along its periphery, and within the blue and green clusters on the right side of the figure. In close proximity, there are additional highly linked papers (between 108 and 103 links).

This cluster explores the embedding of sustainability principles with data analytics (Brenner 2018) and information technology (Vidmar et al. 2021) for adapting business models to digital sustainability (Acciarini et al. 2022; Bencsik et al. 2023). Highly cited papers in this cluster (between 130 and 78 citations) have a significant influence on the field of digital sustainability (Di Vaio et al. 2020; Strandhagen et al. 2017) and digital platforms (Andreassen et al. 2018; Piscicelli et al. 2018). Digital platforms can contribute to sustainable business models by promoting the peer-to-peer sharing of underutilized assets (Piscicelli et al. 2018) and creating value for internal and external stakeholders (e.g., buyers, sellers/suppliers, and platform firms) (Andreassen et al. 2018).

Companies must possess specific data-driven and sustainable capabilities to innovate traditional business models into sustainable ones. To establish digital sustainability and build digital platforms, companies must ensure IT capability (Minatogawa et al. 2020) and computational capability (Martín et al. 2021), analyze the retrieved data (data capability) (Ringvold et al. 2022; Wardhana et al. 2023), make decisions based on data (decision-making capability) (Andersen et al. 2022), and, more specifically, possess digital platform capability (Karimi and Walter 2021; Yousaf et al. 2021).

Sustainable capabilities are prominently discussed in this cluster, and we define them as organizational capabilities essential for facilitating sustainable value propositions. Companies must scan the business environment and cultivate a sense of urgency to innovate their business models (Andersen et al. 2022). Additionally, they must develop their capabilities through partners (partnership management capability) and possess the social capital required to establish such relationships (navigation capability) (Ringvold et al. 2022).

4.1.2 | Digital Circular Economy

The green cluster (36 items)—positioned in the upper-right section of the figure—is the second largest. It displays a lower density than the red cluster—located on the left side of the figure—suggesting some topical distance between publications while remaining connected by the common focus on the digital circular economy. The most linked papers in the cluster (between 116 and 109 links) represent this focus by developing conceptual models that explore how digital technologies can be used for business model innovation within the circular economy (Ávila-Gutiérrez et al. 2020; Burmaoglu et al. 2023; Ranta et al. 2021). They also derive tools for analyzing, ideating, and developing circular innovation ecosystems (Konietzko et al. 2020).

The most cited articles (between 289 and 79 citations) investigate how I4.0 technologies (e.g., IoT, AI) enable circular economy practices in the manufacturing sector (Nascimento et al. 2019), thus contributing to achieving sustainability goals (Dantas et al. 2021). I4.0 technologies can support the transition from linear to new circular business models (García-Muiña et al. 2019; Manea et al. 2021) or even to digital circular ones (Rodrigues Dias et al. 2022; Turner et al. 2019).

An article by Ranta et al. (2021), distinguished by its 116 links and 85 citations, underscores the importance of data-driven capabilities in achieving circular economy goals. The remanufacturing capability encompasses components, such as improved product design and maintenance, which drive business model innovation (Ranta et al. 2021). The need to build data-driven capabilities is evident (Kim et al. 2022), including technological (Khan, Shah, et al. 2022), machine learning (Çetin et al. 2021), data analysis (Benedettini 2022), and information storage capabilities (Kumar and Chopra 2022). By contrast, sustainable capabilities are not addressed.

4.1.3 | Smart Manufacturing and Circular Supply Chains

The blue cluster (28 items)—positioned in the lower-right section of the figure—focuses on smart manufacturing and circular supply chains. Its central hub revolves around Khan, Ahmad, et al. (2021) (106 links) and other highly linked papers (between 89 and 85 links), highlighting how the integration of I4.0 technologies facilitates smart (re)manufacturing (Ghobakhloo 2020; Khan et al. 2023). Strengthening connections among product manufacturers, users, and remanufacturers highlights open innovation and co-creation with partners as key success factors for integrating stakeholder interests (Lardo et al. 2020). Highly cited (between 338 and 63 citations) and thus foundational publications center on supply chain digitalization and integration (Ghobakhloo 2020), changes in value creation caused by I4.0 technologies impacting the entire supply chain (Birkel et al. 2019), and sustainable supply chain management (Esmaeilian et al. 2020; Khan, Ahmad, et al. 2021).

The data-driven capabilities in this cluster focus on I4.0 (Belhadi et al. 2022), blockchain technology (Esmaeilian et al. 2020), and analytics capabilities (Chatterjee et al. 2022). Applying circular principles (e.g., circular procurement and design) within business models, supported by I4.0 capability, facilitates the integration of supply chain sustainability with data-driven practices (Belhadi et al. 2022; Gopal et al. 2024). These sustainable supply chain business models are further strengthened by AI-enhanced knowledge-management processes (Di Vaio et al. 2023) and the application of circular process capabilities (Dahmani et al. 2021).

As circular supply chains rely on blockchain, blockchain technology capabilities become critical for enabling decentralized data collection, improving system efficiency, and supporting performance reporting across supply chain networks (Esmaeilian et al. 2020). Real-time analytics capabilities are also essential for transforming traditional business models into technology-enabled, sustainable ones (Chatterjee et al. 2022). Data-driven technologies (e.g., machine learning and predictive analytics) and interconnected smart technologies (e.g., sensors, indicators, and smart devices) contribute to developing economically, socially, and environmentally sustainable processes, for example, through lifecycle monitoring (Kluczek et al. 2023; Sadeghi et al. 2022). This underscores the growing importance of environmentally focused capabilities in achieving sustainability outcomes (Kumar et al. 2022).

4.1.4 | Blockchain-Enabled Sustainability

The yellow cluster (five items) is vertically dispersed in the center of the figure, with considerable distances separating the rarely cited, specialized contributions, suggesting a weak emphasis on blockchain-enabled sustainability. The publications with the highest number of links (between 75 and 69 links) within this cluster are closely situated and linked to the red cluster on the left side of the figure, aligning with its digital sustainability theme and focusing on blockchain technology to support the development of new sustainable business models (Calandra et al. 2022; Dal Mas et al. 2020; Massaro et al. 2020).

4.1.5 | Smart and Circular Servitization

The purple cluster (seven items)—horizontally dispersed in the center of the figure—focuses on smart and circular servitization. This cluster serves as a topical bridge between the three largest clusters: red, green, and blue. Zheng et al. (2019) is the central publication, marked by high connectivity (73 links) and frequent citations (124 citations). Digital technologies and services are integrated into traditional product-based business models (smart servitization), while platform approaches (e.g., e-marketplaces) are used to leverage the value of these technologies (Zheng et al. 2019). Other noteworthy contributions include those of Paiola et al. (2021) (101 links) and Pirola et al. (2020) (61 citations).

The transition from traditional business models to smart and circular servitization business models is driven by the digital transformation of businesses, coupled with the adoption of circular economy principles. This shift is enabled by product-service systems, which combine physical products with digital services to create new value (Paiola et al. 2021; Pirola et al. 2020).

A notable characteristic of this cluster is its emphasis on data-driven capabilities, such as blockchain technology capability. Translating blockchain technology into environmental innovation in business models requires value-appropriation capability to balance value creation with value capture (Chin et al. 2022). Zheng et al. (2019) emphasize the significance of digitalization capability, a multifaceted concept that encompasses connection, intelligence, and analytic capabilities. Complementing the discourse on digitalization, digital platform capability, decision-making capability based on data, data management capability (Thomson et al. 2022), and data-sharing capability (Langley 2022) are critical. Langley (2022) also highlighted the emerging trend of servitization capability, which reflects a shift toward value-added services and customer-centric strategies.

4.2 | Inter-Cluster Analysis: Exploring Dynamic Capabilities

After analyzing the five clusters individually, their interrelationships are discussed. The red cluster on the left side is dense, with only a few exceptions at the periphery, such as Strandhagen et al. (2017) and Piscicelli et al. (2018), indicating its strict focus. It is relatively distant from the green and blue clusters on the upper right and lower right sides, respectively.

The close connection between the green and blue clusters suggests overlapping content, particularly concerning circularity. The central hub of the blue cluster, anchored by Khan, Ahmad, et al. (2021) and other highly linked papers nearby, is strongly associated with the green cluster, sharing its focus on the circular economy. The yellow and purple clusters, which are small and dispersed in the center of the figure, act as links between the three major clusters, occupying the free space between them.

We can conclude from the bibliographic coupling map that while all clusters address the overarching theme of data-driven sustainable business model innovation, two central research streams emerge: digital sustainability (red cluster) and sustainable digital transformation (green and blue clusters). The red cluster prioritizes sustainability and explores how digital technologies can be leveraged to develop sustainable capabilities and achieve data-driven sustainable business model innovation. The green and blue clusters prioritize digital transformation and explore how data-driven capabilities lead to circular business models, especially within manufacturing companies. Table 3 provides an overview of all the capabilities discussed, organized into data-driven and sustainable categories, along with the clusters in which they appear and their corresponding references.

Data-driven and sustainable capabilities are grounded in dynamic capabilities theory, which is often associated with Teece's framework of sensing, seizing, and transforming. Dynamic capabilities comprise the routines and skills that enable companies to innovate their business models (Teece 2014, 2016). For example, they allow companies to *sense* emerging opportunities, develop new business models to *seize* them, and *transform* the company to align with these opportunities (Teece 2018). Our core argument, drawn from the intellectual structure of data-driven sustainable business model innovation, is that companies require dynamic capabilities—specifically data-driven and sustainable capabilities—for business model innovation.

4.3 | A Process Model for Data-Driven Sustainable Business Model Innovation

We derived a capability-based process model (see Figure 4). The model is read from left to right, as indicated by the arrows, and is organized into four phases of the business model innovation

TABLE 3 | Dynamic capabilities for data-driven sustainable business model innovation.

Main category	Subcategory	Cluster	Key references	Research design: Ql	Research design: Qn
Data-driven capabilities	Digital capability	Red cluster	Ringvold et al. (2022)	✓	
			Wardhana et al. (2023)		✓
		Green cluster	Chauhan et al. (2022)	✓	
			Kim et al. (2022)	✓	
			Ranta et al. (2021)	✓	
	Digitalization capability	Purple cluster	Zheng et al. (2019)	✓	
	Digital platform capability	Red cluster	Karimi and Walter (2021)		✓
			Yousaf et al. (2021)		✓
		Purple cluster	Thomson et al. (2022)	✓	
	Data capability	Red cluster	Ringvold et al. (2022)	✓	
			Wardhana et al. (2023)		✓
	Data-based decision-making capability	Red cluster	Andersen et al. (2022)	✓	
		Purple cluster	Thomson et al. (2022)	✓	
	Data management capability	Purple cluster	Thomson et al. (2022)	✓	
	Data-sharing capability	Purple cluster	Langley (2022)	✓	
	Data analysis capability	Green cluster	Benedettini (2022)	✓	
	Analytical capability	Green cluster	Ranta et al. (2021)	✓	
		Blue cluster	Sahoo and Jakhar (2023)		✓
		Purple cluster	Zheng et al. (2019)	✓	
	Real-time analytics capability	Blue cluster	Chatterjee et al. (2022)		✓
	Technological capability	Green cluster	Khan, Shah, et al. (2022)	✓	
	I4.0 capability	Blue cluster	Belhadi et al. (2022)	✓	✓
	Remanufacturing capability	Green cluster	Ranta et al. (2021)	✓	
	IT capability	Red cluster	Minatogawa et al. (2020)	✓	✓
	Computational capability	Red cluster	Martín et al. (2021)	✓	
	Machine learning capability	Green cluster	Çetin et al. (2021)	✓	
	Cyber capability	Red cluster	Yrjölä et al. (2020)	✓	
	AI capability (forecasting capability)	Green cluster	Çetin et al. (2021)	✓	
			Ranta et al. (2021)	✓	
	Blockchain technology capability (predictive cap., maintenance service cap.; value appropriation cap.)	Red cluster	Martín et al. (2021)	✓	
		Green cluster	Kumar and Chopra (2022)	✓	
			Ranta et al. (2021)	✓	
		Blue cluster	Esmaeilian et al. (2020)	✓	
		Purple cluster	Chin et al. (2022)		✓
	Information storage capability	Green cluster	Kumar and Chopra (2022)	✓	
	Information processing capability	Purple cluster	Zheng et al. (2019)	✓	
	Tracking capability	Green cluster	Ranta et al. (2021)	✓	
	Logistics capability	Blue cluster	Awan et al. (2022)	✓	
		Green cluster	Benedettini (2022)	✓	
	Servitization capability	Purple cluster	Langley (2022)	✓	

(Continues)

TABLE 3 | (Continued)

Main category	Subcategory	Cluster	Key references	Research design	
				Ql	Qn
Sustainable capabilities	Communication capability	Red cluster	Martín et al. (2021)	✓	
	Capability to scan business environment	Red cluster	Andersen et al. (2022)	✓	
	Capability to convey a sense of urgency	Red cluster	Andersen et al. (2022)	✓	
	Managerial capability	Red cluster	Minatogawa et al. (2020)	✓	✓
	Marketing capability	Red cluster	Minatogawa et al. (2020)	✓	✓
	Strategic perspective capability	Red cluster	Wardhana et al. (2023)		✓
	Recombination capability (rethinking)	Red cluster	Ringvold et al. (2022)	✓	
	Adaptive capability	Red cluster	Wardhana et al. (2023)		✓
	Partnership management capability	Red cluster	Ringvold et al. (2022)	✓	
	Network capability	Red cluster	Wardhana et al. (2023)		✓
	Navigation capability	Red cluster	Ringvold et al. (2022)	✓	
	Efficiency-minded capability	Red cluster	Ringvold et al. (2022)	✓	
	Effectuation capability	Red cluster	Ringvold et al. (2022)	✓	
	Administrative capability	Blue cluster	Sahoo and Jakhar (2023)		✓
	Circular process capability	Blue cluster	Dahmani et al. (2021)	✓	
	Environmentally focused capability	Blue cluster	Kumar et al. (2022)	✓	✓

Abbreviations: Ql = qualitative, Qn = quantitative.

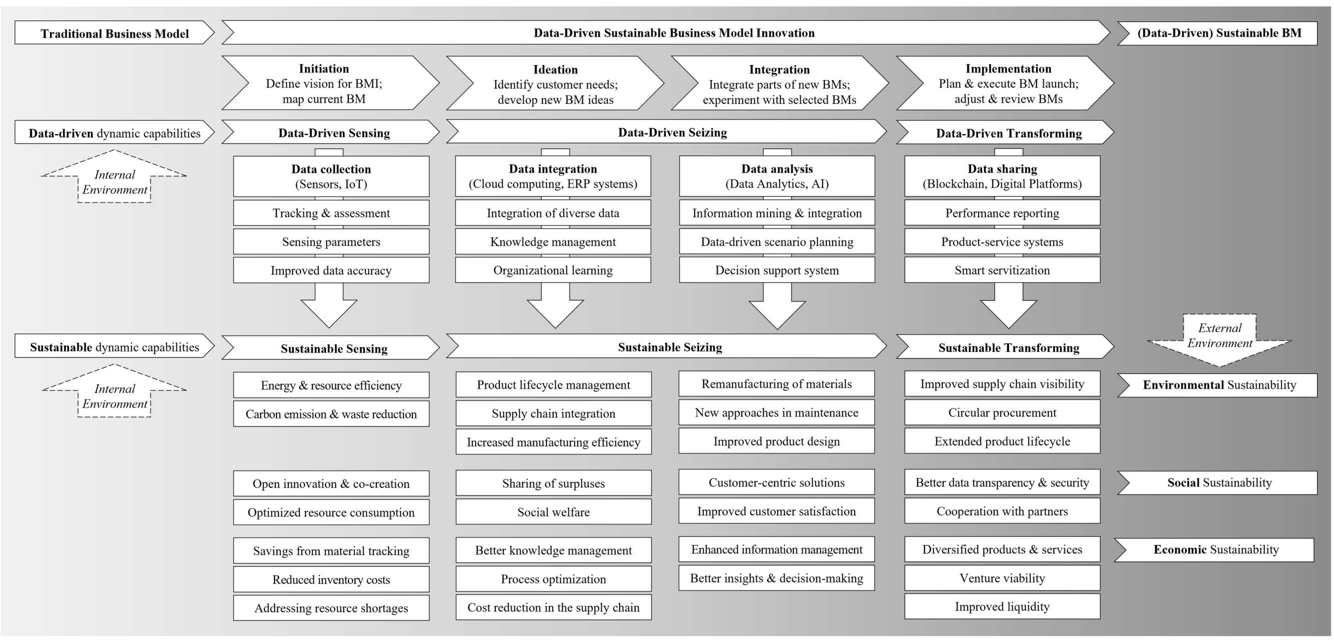

FIGURE 4 | Process model for data-driven sustainable business model innovation Legend: AI = artificial intelligence, BM = business model, BMI = business model innovation, ERP = enterprise resource planning, IoT = Internet of Things.

process. Each phase outlines the data-driven dynamic capabilities, their associated technologies, and the sustainable dynamic capabilities, along with their effects on environmental, social, and economic sustainability. Vertical arrows point downward from the data-driven dynamic capabilities to represent their impact on the sustainable dynamic capabilities and sustainability at all three levels. Technologies are shown along the arrows to indicate that they are tools used to facilitate this impact. Stakeholder influence is depicted as follows: the internal environment influences both data-driven and sustainable dynamic capabilities, with arrows pointing upward. The external environment affects the three sustainability levels, with the arrow pointing downward. The different arrow directions help distinguish between the internal and external environments.

The capability-based process model connects the research streams of sustainability and data-driven technologies in business model innovation, illustrating the process of transitioning from a traditional business model to a (data-driven) sustainable business model. A business model can be described as data-driven when data is used as a key resource and data processing becomes a core activity (Hartmann et al. 2016). All phases of the business model innovation process, along with the guidance provided throughout, hold significant potential to be supported by data-driven methods and tools (Trabucchi and Buganza 2019).

In our capability-based process model, we categorized the technologies predominantly used in each phase, synthesizing existing research into the headings "Data collection," "Data integration," "Data analysis," and "Data sharing." Each of these phases also includes relevant subheadings, which serve as exemplary application areas and outcomes (Chauhan et al. 2022; Esmaeilian et al. 2020; Ranta et al. 2021). However, these technologies are not confined exclusively to their designated phases and can be applied throughout the innovation process.

Business model innovation capabilities are the unifying threads across all five clusters (see Table 3). Therefore, we included dynamic capabilities as the cornerstone of our model for data-driven sustainable business model innovation. The core message of dynamic capability theory is that a company's success depends not only on its existing capabilities but also on its ability to continuously adapt and reconfigure those capabilities in response to a rapidly changing business environment (Teece 2007, 2018). While the concept of dynamic capabilities is often associated with Teece, other scholars, such as Helfat and Peteraf (2003) and Helfat and Raubitschek (2018), highlight the lifecycle dynamics of capabilities, including their founding, development, and maturity.

Dynamic capabilities allow companies to continually monitor the external environment, identify new opportunities, and integrate novel elements into their business models (Helfat and Raubitschek 2018; Lantano et al. 2022). Both internal forces (e.g., managers) and external forces (e.g., the environment) can moderate the deployment of dynamic capabilities. Specifically, external forces impact the links between dynamic capability deployment and the outcomes of the value creation process (Ambrosini and Bowman 2009).

The development of data-driven capabilities (Vrontis et al. 2022) and sustainable capabilities (Chin et al. 2022; Hajiheydari et al. 2022) can drive business model innovation, enabling companies to innovate their existing business models. We incorporated stakeholder influence in our process model in two ways. First, the internal environment influences data-driven and sustainable dynamic capabilities. Second, the external environment influences environmental, social, and economic sustainability, which forms the link between the deployment of dynamic capabilities and the outcomes of the business model innovation process.

Based on our review, we identified two sets of dynamic capabilities: (1) data-driven sensing, data-driven seizing, and data-driven transforming (Warner and Wäger 2019), and (2) sustainable sensing, sustainable seizing, and sustainable transforming (Hajiheydari et al. 2022; Pieroni et al. 2021). Following Teece (2018), we can describe these three types of dynamic capabilities as follows. Sensing aims to identify emerging sustainable issues and digital opportunities (i.e., unmet customer needs) and translate them into data-driven business model ideas, which, in turn, help companies develop sustainable business model ideas. Seizing focuses on configuring and refining business model concepts for data-driven and, subsequently, sustainable business model innovation, allowing companies to seize opportunities and capture their value. Transforming seeks to align existing capabilities, build the capabilities required for data-driven and sustainable business models, and plan the implementation of business model innovations.

We built on the work of Ranta et al. (2021) and Chauhan et al. (2022) to incorporate data-driven and sustainable dynamic capabilities into the four phases of the business model innovation process. The capabilities of sensing, seizing, and transforming were assigned to the following phases: the initiation phase corresponds to sensing, the ideation and integration phases align with seizing, and the implementation phase is linked to transforming (Pieroni et al. 2019; van Eechoud and Ganzaroli 2023).

Pieroni et al. (2019) presented a process model for circular business model innovation from a dynamic capabilities perspective. In comparison, our process model extends the existing sustainability perspective to include digital transformation aspects and the associated dynamic capabilities. Thus, our work aligns with existing research that highlights data as both a key driver and a critical factor in developing dynamic capabilities (Tortora et al. 2021), and shows that strong dynamic capabilities support digital transformation and AI adoption for value creation (Cimino et al. 2025; Matarazzo et al. 2021), foster competitive advantage in dynamic markets (Mondal et al. 2025; Singh et al. 2025), and facilitate adaptation to environmental change and progress toward sustainability goals (Cimino et al. 2025; Mondal et al. 2025).

Our findings contrast slightly with related research, as our model focuses specifically on business model innovation, while digital transformation extends beyond business models, influencing organizational culture, processes, technologies, and the workforce (Al-Moaid and Almarhdi 2024)—areas that we do not examine in detail. While the process model by van Eechoud and Ganzaroli (2023) explores dynamic capabilities in digital circular business model innovation, our process model extends theirs by distinguishing between data-driven and sustainable dynamic capabilities, providing a more detailed breakdown of data-driven technologies in the innovation process, and analyzing their effects on all three levels of sustainability—not just environmental sustainability.

In the initiation phase, data-driven dynamic capabilities are primarily used for data collection, which requires technologies, such as sensors and the IoT (Ranta et al. 2021). These technologies facilitate the tracking, assessment, and sensing of parameters, improving data accuracy (Chauhan et al. 2022). They also contribute to sustainable dynamic capabilities that support sustainability across all three dimensions.

Environmental sustainability is enhanced through improvements in renewable energy and resource efficiency (Del Vecchio et al. 2022; Ranta et al. 2021), as well as reductions in carbon emissions and waste (Ghobakhloo 2020; Nascimento et al. 2019).

Social sustainability is achieved through open innovation and co-creation with partners, which is made possible by strengthening connections among product manufacturers, users, and remanufacturers (Lardo et al. 2020). Another aspect of consumers is the optimized consumption of resources, including materials and energy (Esmaeilian et al. 2020; Godina et al. 2020).

Economic sustainability is supported by the capability to track products and materials (e.g., material passports/databanks), enabling knowledge accumulation that can lead to savings from waste and surplus reduction (Çetin et al. 2021; Ranta et al. 2021). Additionally, improved inventory management can reduce costs and address resource shortages (Godina et al. 2020; Mukherjee and Wood 2021).

During the ideation phase, data-driven dynamic capabilities support data integration—enabled by tools, such as cloud computing and enterprise resource planning (ERP) systems—which help integrate diverse data, manage knowledge, and support organizational learning (Di Vaio et al. 2023; Wardhana et al. 2023).

Environmental sustainability is bolstered by product lifecycle management (Zheng et al. 2019) and supply chain integration (Belhadi et al. 2022; Chauhan et al. 2022; Gopal et al. 2024), with the latter benefiting from logistics capabilities (Awan et al. 2022; Benedettini 2022). Manufacturing efficiency can be enhanced by shortening production times (Godina et al. 2020) and improving productivity (Dahmani et al. 2021; Hanelt et al. 2017).

Social sustainability is positively influenced by the connection between supply and demand, which facilitates the sharing of surpluses (de Oroski and da Silva 2022), thereby enhancing social welfare (Chauhan et al. 2022). Digital technologies empower small-scale production on the supply side while improving access to customers and consumers on the demand side (George et al. 2021).

Economic sustainability is enhanced by improved knowledge management processes (Di Vaio et al. 2023) and process optimization, such as efficient material processing and streamlined logistics (Ranta et al. 2021). Decreased costs in logistics (Godina et al. 2020), supply chains, investments, and social scalability (Calandra et al. 2022) are possible outcomes.

In the integration phase, data analysis is facilitated by data analytics and AI, requiring companies to excel in real-time analytics (Chatterjee et al. 2022) and AI capabilities (Çetin et al. 2021). Data-driven dynamic capabilities encompass information mining and integration (Kumar and Chopra 2022; Zheng et al. 2019), data-driven scenario planning (Warner and Wäger 2019), and support systems for decision-making (Pirola et al. 2020).

Environmental sustainability benefits from recycling, reusing, and remanufacturing materials and components. Therefore, remanufacturing capabilities are necessary and encompass components, such as improved maintenance and product design (Langley 2022; Murray et al. 2017; Ranta et al. 2021). Possible outcomes include adopting new organizational approaches in equipment maintenance (Chen et al. 2018; Martín et al. 2021) and developing eco-efficient products (Dahmani et al. 2021; García-Muiña et al. 2019; Manea et al. 2021).

Social sustainability is achieved as customers benefit from more customer-centric solutions (Minatogawa et al. 2020), resulting in enhanced customer satisfaction (Dahmani et al. 2021) and improved user experience (Martin and Bustamante 2021).

Economic sustainability is facilitated through enhanced information management (Dahmani et al. 2021) and improved insights and decision-making (Andersen et al. 2022; Lardo et al. 2020), as the workforce is equipped with new decision-making tools (Esmaeilian et al. 2020). However, this also necessitates the development of data-based decision-making capabilities (Andersen et al. 2022; Thomson et al. 2022).

During the implementation phase, data-driven dynamic capabilities involve data sharing facilitated by blockchain technology and digital platforms. The adoption of blockchain technology enhances system efficiency and facilitates performance reporting across supply chain networks (Chin et al. 2022; Esmaeilian et al. 2020; Kumar and Chopra 2022; Martín et al. 2021; Ranta et al. 2021). Supported by servitization capability, more companies are employing product-service systems that enable smart servitization (Langley 2022).

Environmental sustainability is positively influenced by blockchain technology through improved traceability (Mercuri et al. 2021) and greater transparency in the supply chain (Kumar and Chopra 2022). Circular supply chains (Esmaeilian et al. 2020) can result from the incorporation of circular principles (Belhadi et al. 2022; Gopal et al. 2024), further supported by circular process capability (Dahmani et al. 2021). Such circular principles include circular design and procurement (Mukherjee and Wood 2021). Digital technology-based services can extend a product's lifecycle (Kim et al. 2022).

Social sustainability is supported by technologies that enhance transparency, stakeholder inclusion, and collaborative partnerships. Blockchains improve the transparency and security of data access within a given system, while digital platforms enable cooperation with external partners (e.g., competitors) and the inclusion of shareholders (Awan et al. 2022; Chin et al. 2022; Kim et al. 2022). Involving internal and external stakeholders (Holzmann and Gregori 2023) and garnering their support (Biloslavo et al. 2020) necessitates partnership management (Ringvold et al. 2022) and network capabilities (Wardhana et al. 2023).

Economic sustainability is positively impacted by the adoption of data-driven and circular approaches (Ghobakhloo 2020; Paiola et al. 2021), which foster more diversified and competitive product and service offerings (da Rocha et al. 2022; Mukherjee and Wood 2021). These developments contribute to enhanced venture viability (Holzmann and Gregori 2023) and improved liquidity (George et al. 2021).

We provide a hypothetical example, inspired by the real-world case of a ceramic tile manufacturer (García-Muiña et al. 2018), to illustrate the application of the process model in sustainability-oriented decision-making. In the initiation phase, the company mapped its existing linear business model, identified high waste generation as a key sustainability challenge, and leveraged IoT technologies to collect data on resource usage. During the ideation phase, data-driven insights facilitated the evaluation of circular business models, supported by ERP systems for data integration. The integration phase employed AI-driven scenario planning to assess environmental impacts and optimize remanufacturing processes. Finally, in the implementation phase, blockchain technology enabled data sharing across supply chain networks, thereby reinforcing circularity and sustainability. This example illustrates how organizations can apply our process model to inform decision-making in the context of data-driven sustainable business model innovation.

Thus, data-driven and sustainable dynamic capabilities are interconnected throughout the business model innovation process. Data-driven sensing, seizing, and transforming can lead to sustainable sensing, seizing, and transforming. In other words, the use of data-driven technologies can enable sustainability practices, thereby (ideally) positively impacting the three dimensions of sustainability.

However, while data-driven technologies can positively affect sustainability, their potential negative effects must not be overlooked. Mustak and Plé (2020) described the disadvantages of positive bias, which can limit the explanatory power of a concept or logic by offering an overly optimistic and favorable perspective. Similarly, we argue that research on the sustainable outcomes of data-driven technologies may fall victim to a positive bias that overlooks the adverse effects these technologies can have on the environment and society. Thus, the proposed process model presents an ideal case. However, it is important to recognize that digital technologies can negatively affect environmental, social, and economic sustainability (Birkel et al. 2019).

Nonetheless, our process model offers a valuable framework for both theory and practice, helping to understand the relationship between data-driven and sustainable business model innovation. By mitigating the risks associated with these technologies, we can harness their potential to create positive outcomes for the environment, society, and economy.

5 | Discussion

5.1 | Theoretical Contributions and Implications

Our study makes two key theoretical contributions to the literature on data-driven sustainable business model innovation. First, we further conceptualize the field by identifying five research clusters, each offering distinct insights into how data-driven technologies drive sustainable business model innovation. Second, based on insights gathered from these research streams, we develop a new dynamic capabilities-based process model that explains how data-driven and sustainable dynamic capabilities interact throughout the innovation process.

We identify five research clusters that structure the discourse on data-driven sustainable business model innovation: Cluster 1 explores how digital platforms contribute to sustainable business models, underscoring the need to integrate data-driven and sustainable capabilities. Cluster 2 examines the use of digital technologies to transition from linear to circular business models and finds that the sustainable capabilities required to achieve circular economy goals remain largely unknown. Cluster 3 focuses on smart manufacturing and supply chain digitalization, demonstrating how circular principles align supply chain sustainability with data-driven capabilities. Cluster 4 investigates blockchain's role in sustainable business model innovation. Cluster 5 analyzes how digital transformation enables smart and circular servitization business models, highlighting servitization capability as a pathway to value-added services and customer-centric strategies.

Building on insights from the five clusters, we present a dynamic capabilities-based process model that explains how data-driven technologies can enable sustainable business model innovation. Following Makadok et al. (2018), our theoretical contribution lies not in developing new “grand theories,” but in extending existing ones. Our process model advances theories in sustainable business model innovation in three ways: First, it addresses how data-driven technologies can be integrated into the innovation process to foster sustainable business model development, an aspect previously underexplored.

Second, our model builds upon existing process theory-inspired process models (Chesbrough and Rosenbloom 2002; Teece 2010) that consider the dynamic and iterative nature of business model innovation. This expansion applies dynamic capabilities theory to explain the transformation of traditional business models into (data-driven) sustainable business models.

Third, the process model offers a theoretical conceptualization of how data-driven and sustainable dynamic capabilities interact during business model innovation. Data-driven capabilities likely operate indirectly in the sensing and seizing phases, while their direct influence may emerge only in the transforming phase, where business model implementation occurs. Based on our literature review, we propose that while data-driven capabilities alone may enhance efficiency, their impact could become more targeted when combined with sustainable capabilities.

Overall, the process model explains the mechanisms through which companies can utilize data-driven technologies to reconfigure their business models for positive environmental, social, and economic impacts.

The significance of strong dynamic capabilities in business model innovation is well-established (Teece 2018). This study demonstrates that this principle also applies to data-driven sustainable business model innovation. Using a dynamic capabilities lens, we identify the data-driven and sustainable capabilities that companies leverage to create value in business model innovation. Thus, this study contributes to the literature on dynamic capabilities by connecting the business model innovation process with the processes of sensing, seizing, and transforming. In conclusion, we offer a new perspective on the dynamic and interconnected process of data-driven sustainable business model innovation.

5.2 | Limitations and Directions for Future Research

Limitations stem from the methodology and its implementation. The search was limited to the WoS database. A comparison with Scopus revealed a high degree of content overlap, as both databases index the leading journals in the Scimago Journal Rank subcategory "Business, Management, and Accounting." The key journals—ranked by (1) the most frequently cited contributions, (2) the most relevant contributions, and (3) the highest number of publications in the sample—are included in both WoS and Scopus. However, the exclusion of Scopus may have led to the omission of relevant studies, as searching additional databases could have expanded the sample size and yielded different results.

Another limitation concerns the subjectivity inherent in article selection and analysis. Although several researchers were involved in conducting the systematic literature review, objectivity can only be partially ensured. To address these limitations in future research, scholars could extend their search to other databases to explore the literature and theoretical frameworks comprehensively. Furthermore, they could enhance the reliability and validity of data collection and analysis by involving researchers from diverse backgrounds.

Our work opens several avenues for future research, including validating the process model, identifying, developing, and measuring critical dynamic capabilities, and extending the process model to the ecosystem level. To guide future research in this field, we have created a plan exploring the identified research areas, research questions, and potential methodologies (see Table 4). This plan integrates the insights from our bibliographic coupling analysis and process model.

The five clusters identified in the bibliographic coupling map (see Figure 3) highlight key research streams. Each cluster represents distinct implications for future research. Cluster 1 raises questions about how digital platforms can contribute to sustainable business models, particularly by fostering strong relationships with partners. Cluster 2 suggests investigating

TABLE 4 | Research agenda.

Research area	Research questions	Potential methodologies
Validation of process model	Does the process model accurately reflect the data-driven process of sustainable business model innovation?	Expert interviews, surveys
	Can the process model serve as a helpful guideline for companies in designing their innovation processes?	Longitudinal case studies
	What adaptations to the process model are necessary to account for the sustainability-damaging effects of technologies?	Impact assessments
Critical dynamic capabilities	What key dynamic capabilities enable successful data-driven sustainable business model innovation?	Mixed-methods approach
	How can companies develop the required capabilities for data-driven sustainable business model innovation?	Expert interviews
	How can the effectiveness of dynamic capabilities in driving sustainable business model innovation be measured?	Develop and validate metrics (e.g., through factor analysis)
	How do data-driven capabilities directly and indirectly impact sustainability outcomes?	Cross-impact analysis
Extension of the process model to the ecosystem level	How can data-driven technologies boost sustainability throughout supply chains?	Mixed-methods approach
	How do dynamic capabilities mediate between partners in supply chain networks?	Surveys, structural equation modeling
	How can companies ensure shared value creation through their sustainable business models?	Stakeholder analysis

Note: Table structure adapted from tables included in Mahajan et al. (2024, pp. 11–24) and Centobelli et al. (2020, pp. 12–13).

how manufacturing companies can effectively implement sustainable capabilities to achieve circular economy goals. Cluster 3 raises future research questions regarding the achievement of sustainability objectives within supply chains. Cluster 4 focuses on the role of blockchain in advancing sustainable business model innovations. Cluster 5 encourages research on the intersection of servitization capability with other data-driven and sustainability-related capabilities.

The digital technologies and dynamic capabilities identified by analyzing the five clusters were integrated into our process model (see Figure 4), but their validation remains outstanding. Future research should assess whether this model accurately reflects the data-driven process of sustainable business model innovation and whether it can serve as a guideline for companies to design their innovation processes. Additionally, changing the business model by introducing technological and sustainability components carries significant risks for companies (Tohănean et al. 2020). Cases where the application of data-driven technologies in business model innovation has not led to sustainable outcomes need further investigation to identify the necessary adaptations to the process model and move it from an ideal case to a more realistic one.

Dynamic capabilities play an important role in the business model innovation process. However, the challenge for companies lies in simultaneously managing data-driven and sustainable dynamic capabilities. This challenge is further complicated by the influence of internal and external factors on the business model innovation process (Ambrosini and Bowman 2009). When integrating these data-driven and sustainable capabilities, companies face similar challenges in balancing the tensions between adopting new technologies and achieving sustainability goals (Kumar et al. 2022).

The key challenges are as follows: First, internal stakeholder resistance—such as from employees and managers—to organizational change. This resistance is especially prevalent when innovations are integrated into conventional processes and focused sustainable capabilities are lacking (Kumar et al. 2022). Second, the external environment can pose a significant barrier to technological adoption. Specifically, companies may struggle to select appropriate technologies due to the vast number of available options (Sahoo and Jakhar 2023).

Further research is needed to determine which dynamic capabilities are crucial for successfully implementing business model innovations and how companies can develop these capabilities. Moreover, questions arise regarding how the effectiveness of dynamic capabilities in achieving sustainable business model innovation can be measured and how data-driven capabilities directly and indirectly impact sustainability outcomes.

Companies are embedded in extensive networks within their ecosystem, comprising diverse stakeholders, such as suppliers, customers, and competitors. Collaborations with these stakeholders facilitate co-creation (Brown et al. 2021; Ramaswamy and Ozcan 2018) and the development of more sustainable value propositions (Bocken and Geradts 2020). However, ecosystem actors face coordination and collaboration challenges in aligning with new value propositions, which can be addressed through orchestration driven by dynamic capabilities (Kanda et al. 2025). Therefore, an important avenue for future research is extending our process model to the ecosystem level to consider companies within their supply chain networks and their approaches to shared value creation.

Data-driven technologies offer new opportunities for cooperation with stakeholders (Adelekan and Sharmina 2024) and help realize sustainable supply chain business models (Di Vaio et al. 2023; Esmaeilian et al. 2020). Partners (e.g., producers, suppliers, processors, distributors, and retailers) in such sustainability-oriented supply chains tend to build positive performance relationships (Shashi et al. 2018). Future research must explore how data-driven technologies can boost sustainability throughout supply chains and how dynamic capabilities mediate relationships between partners in supply chain networks.

Changes in value creation caused by digital technologies impact the entire supply chain (Birkel et al. 2019) and lead to considerations regarding how value is shared along the supply chain. The principle of shared value proposes that companies must integrate a social perspective so that their business activities benefit both themselves and society (Porter and Kramer 2006, 2011). Integrating economically disadvantaged individuals into the supply chain can create shared value depending on the company's level of inclusivity—that is, from being used only in distribution to being used along the entire supply chain (Panapanaan et al. 2016). Future research could explore how companies can ensure that their sustainable business models generate economic value while simultaneously creating value for society by addressing societal concerns.

6 | Conclusion

In conclusion, this paper makes a valuable contribution to the increasingly relevant field of data-driven sustainable business model innovation by connecting data-driven and sustainable business model innovation. We developed a comprehensive dynamic capability-based process model that conceptualizes how data-driven technologies can contribute to sustainable business model innovation while promoting environmentally, socially, and economically sustainable development. This study provides a new perspective on the dynamic and interconnected process of data-driven sustainable business model innovation.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Appendix

TABLE A1 | Digital sustainability and digital platforms (red cluster).

Author(s) (year)	Journal	Number of citations Google Scholar
Acciarini et al. (2022)	*Journal of Strategy & Management*	71
Amaral and Orsato (2023)	*Business Strategy & the Environment*	16
Andersen et al. (2022)	*Creativity & Innovation Management*	46
Andreassen et al. (2018)	*Journal of Service Management*	221
Autio (2017)	*Strategic Entrepreneurship Journal*	186
Bähr and Fliaster (2022)	*Business Strategy & the Environment*	10
Baranauskas and Raišienė (2022)	*Sustainability*	29
Bencsik et al. (2023)	*Journal of Business Research*	9
Bican and Brem (2020)	*Sustainability*	362
Biloslavo et al. (2020)	*Management Decision*	66
Böttcher et al. (2023)	*Information Systems Journal*	9
Brenner (2018)	*Sustainability*	129
Chen et al. (2018)	*Sustainability*	43
Di Vaio et al. (2020)	*Journal of Business Research*	574
Fuerst et al. (2023)	*Sustainability*	4
Gao and Li (2020)	*Journal of Cleaner Production*	61
García-Muiña et al. (2020)	*Sustainability*	148
Gregori and Holzmann (2020)	*Journal of Cleaner Production*	215
Gregori et al. (2023)	*Business Strategy and the Environment*	0
Haftor et al. (2021)	*Journal of Business Research*	32
Hajiheydari et al. (2022)	*Foresight*	5
Hanelt et al. (2017)	*Information Systems Journal*	140
Holzmann et al. (2020)	*Technological Forecasting & Social Change*	42
Holzmann and Gregori (2023)	*International Journal of Information Management*	46
Iannone and Caruso (2023)	*Sustainability*	6
Jabłoński (2018)	*Sustainability*	54
Karami and Madlener (2021)	*Energy Research & Social Science*	32
Karimi and Walter (2021)	*Sustainability*	39
Kim (2021)	*Sustainability*	29
Li et al. (2020)	*Sustainability*	83
Li et al. (2023)	*Journal of Engineering and Technology Management*	12
Liang et al. (2023)	*Sustainability*	1
Loock (2020)	*Energy Research & Social Science*	82
Martin and Bustamante (2021)	*Frontiers in Sustainable Food Systems*	14
Martín et al. (2021)	*Sustainability*	34
Minatogawa et al. (2020)	*Sustainability*	60
Mukherjee and Wood (2021)	*Sustainability*	12

(Continues)

TABLE A1 | (Continued)

Author(s) (year)	Journal	Number of citations Google Scholar
Oroski and de Oroski and da Silva (2022)	*Waste Management & Research*	10
Parida and Wincent (2019)	*International Entrepreneurship & Management Journal*	173
Piscicelli et al. (2018)	*Journal of Cleaner Production*	182
Principato et al. (2023)	*Industrial Marketing Management*	0
Reuter (2022)	*Business Strategy & the Environment*	31
Ringvold et al. (2022)	*Organization & Environment*	12
Rodrigues (2022)	*International Journal of Entrepreneurial Behavior & Research*	7
Snihur and Markman (2023)	*Journal of Management Studies*	6
Steinhauser (2019)	*Schmalenbach Business Review*	23
Strandhagen et al. (2017)	*Advances in Manufacturing*	348
Tiscini et al. (2020)	*Management Decision*	88
Tohãnean et al. (2020)	*Amfiteatru Economic*	67
Vidmar et al. (2021)	*Sustainability*	32
Wardhana et al. (2023)	*Journal of Business & Industrial Marketing*	1
Wit et al. (2021)	*Energies*	15
Yousaf et al. (2021)	*Sustainability*	102
Yrjölä et al. (2020)	*Sustainability*	37
Zheng et al. (2022)	*Sustainability*	7

TABLE A2 | Digital circular economy (green cluster).

Author(s) (year)	Journal	Number of citations Google Scholar
Ávila-Gutiérrez et al. (2020)	*Sustainability*	32
Benedettini (2022)	*Sustainability*	11
Bressanelli et al. (2020)	*Resources*	69
Bressanelli et al. (2022)	*Sustainability*	52
Burmaoglu et al. (2023)	*International Journal of Productivity & Performance Management*	19
Çetin et al. (2021)	*Sustainability*	159
Chauhan et al. (2021)	*Benchmarking: An International Journal*	110
Chauhan et al. (2022)	*Technological Forecasting & Social Change*	288
Colombi and D'Itria (2023)	*Sustainability*	8
Dantas et al. (2021)	*Sustainable Production & Consumption*	432
Del Vecchio et al. (2022)	*EuroMed Journal of Business*	49
García-Muiña et al. (2019)	*Social Sciences*	116
Giorgi et al. (2022)	*Journal of Cleaner Production*	120
Gräßler and Pottebaum (2021)	*Applied Sciences*	14
Huynh (2022)	*International Journal of Productivity & Performance Management*	73
Illankoon and Vithanage (2023)	*Journal of Building Engineering*	9
Jabbour et al. (2021)	*Production Planning & Control*	22
Jabbour et al. (2020)	*Resources Policy*	151
Khan, Piprani, et al. (2022)	*Operations Management Research*	68
Khan, Shah, et al. (2022)	*Journal of Entrepreneurship in Emerging Economies*	32
Khan, Zia-ul-haq, et al. (2021)	*Business Strategy & Development*	71
Kim et al. (2022)	*Sustainable Production & Consumption*	15
Konietzko et al. (2020)	*Sustainability*	158
Kumar and Chopra (2022)	*Sustainability*	33
Liu, Quddoos, et al. (2022)	*Operations Management Research*	15
Manea et al. (2021)	*Journal of Business Economics & Management*	39
Morea et al. (2023)	*Journal of Knowledge Management*	13
Narayan and Tidström (2020)	*Journal of Cleaner Production*	115
Nascimento et al. (2019)	*Journal of Manufacturing Technology Management*	752
Pizzi et al. (2022)	*Management of Environmental Quality: An International Journal*	32
Ranta et al. (2021)	*Resources, Conservation & Recycling*	331
Rodrigues Dias et al. (2022)	*Journal of Air Transport Management*	21
Schwanholz and Leipold (2020)	*Journal of Cleaner Production*	107
Singh, Babbitt, et al. (2021)	*Clean Technologies & Environmental Policy*	47
Toth-Peter et al. (2023)	*Journal of Cleaner Production*	23
Turner et al. (2019)	*Sustainability*	90

TABLE A3 | Smart manufacturing and circular supply chains (blue cluster).

Author(s) (year)	Journal	Number of citations Google Scholar
Atif et al. (2021)	*Sustainability*	53
Awan et al. (2022)	*Sustainability*	80
Belhadi et al. (2022)	*Supply Chain Management: An International Journal*	101
Birkel et al. (2019)	*Sustainability*	432
Chatterjee et al. (2022)	*Journal of Business Research*	29
da Rocha et al. (2022)	*Heliyon*	24
Dahmani et al. (2021)	*Journal of Cleaner Production*	80
Di Vaio et al. (2023)	*Journal of Enterprise Information Management*	45
Esmaeilian et al. (2020)	*Resources, Conservation & Recycling*	591
Ferreira et al. (2023)	*Journal of Cleaner Production*	24
Fonseca et al. (2021)	*Sustainability*	170
Ghobakhloo (2020)	*Journal of Cleaner Production*	1419
Godina et al. (2020)	*Sustainability*	128
Gopal et al. (2024)	*Journal of Science & Technology Policy Management*	2
Kerin and Pham (2020)	*Journal of Manufacturing Technology Management*	84
Khan, Ahmad, et al. (2021)	*Journal of Cleaner Production*	302
Khan et al. (2023)	*Journal of Cleaner Production*	19
Kluczek et al. (2023)	*Packaging Technology & Science*	4
Kumar et al. (2022)	*International Journal of Computer Integrated Manufacturing*	18
Lardo et al. (2020)	*Management Decision*	58
Lee et al. (2021)	*Advanced Engineering Informatics*	75
Liu, Trevisan, et al. (2022)	*Business Strategy & the Environment*	120
Martínez-Olvera and Mora-Vargas (2019)	*Sustainability*	46
Sadeghi et al. (2022)	*Comprehensive Reviews in Food Science & Food Safety*	21
Romero et al. (2021)	*Sustainability*	82
Sahoo and Jakhar (2023)	*Business Strategy and the Environment*	0
Teixeira and Tavares-Lehmann (2023)	*Competitiveness Review*	7
Vrontis et al. (2022)	*Sustainability*	47

TABLE A4 | Blockchain-enabled sustainability (yellow cluster).

Author(s) (year)	Journal	Number of citations Google Scholar
Calandra et al. (2022)	*Business Strategy & the Environment*	44
Cavazza et al. (2023)	*British Food Journal*	2
Dal Mas et al. (2020)	*Management Decision*	54
Massaro et al. (2020)	*Corporate Social Responsibility & Environmental Management*	59
Mercuri et al. (2021)	*Sustainability*	49

TABLE A5 | Smart and circular servitization (purple cluster).

Author(s) (year)	Journal	Number of citations Google Scholar
Chin et al. (2022)	*Technological Forecasting & Social Change*	70
Diaz and Montalvo (2022)	*Sustainability*	10
Langley (2022)	*Sustainability*	40
Paiola et al. (2021)	*Journal of Business Research*	106
Pirola et al. (2020)	*Computers in Industry*	165
Thomson et al. (2022)	*International Entrepreneurship & Management Journal*	63
Zheng et al. (2019)	*Advanced Engineering Informatics*	298