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SPECIAL ISSUE ARTICLE

Digital-sustainable business models: Definition, systematic literature review, integrative framework and research agenda from a strategic management perspective

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Abstract

The era of digitization coincides with a growing interest in social and environmental sustainability. Management scholars, therefore, turned their attention to the intersection of both trends, seeking a better understanding of how firms can manage digital sustainability. Business models are a central element in the strategic management of digital sustainability. Due to the diverse roots in the digitization literature, the sustainability literature and the business model literature, previous work on digital-sustainable business models is highly fragmented. We, therefore, develop a strategic management framework and conduct an integrative literature review to synthesize fragmented insights, covering 134 studies published between 2007 and 2023 in leading academic journals. Examining the synthesized body of knowledge from the lens of affordances and our framework's inclusive strategic management perspective, we then identify promising avenues for further strategy research. Among others, future research should examine complementarities and conflicts between the three business model dimensions (value propositions, value creation and delivery processes, value capture mechanisms), between multiple options within each dimension, between different digital technologies, between various digital affordances, between digitalization and sustainability and between the outcomes of the triple-bottom-line. More efforts should also be directed towards the antecedents and boundary conditions of digital-sustainable business models and towards questions of generalizability, especially towards generalizable theoretical mechanisms. Our framework, synthesis and research agenda support strategy scholars in advancing our understanding of business models for digital sustainability.

INTRODUCTION

Today's firms witness the coincidence of two main trends (George et al., 2021; Höllerer et al., 2022). First, digital technologies can reshape products and processes to an extent that the resultant digital transformation amounts to an industrial revolution (Giustiziero et al., 2023; Rad et al., 2022). Second, more and more stakeholders are increasingly aware of ecological challenges and social conflicts, identify firms as a source of these problems and pressure them to contribute to the sustainable development of their economies and societies (Adams et al., 2016; Dodgson, 2021).

These two concurrent trends affect firms in a myriad of ways. Their implications may be paradoxical, conflictual or synergistic but are generally non-trivial (Höllerer et al., 2022). Firms should attempt to make the most of the co-occurrence of these trends, derive competitive advantages from this 'twin transformation' (CODES, 2022) and secure their own long-term prosperity. Thus, firms need to manage this 'twin transition' (e.g., Bocken et al., 2023; European Commission, 2022) strategically. Developing and implementing appropriate business models is a powerful method to do so (Foss & Saebi, 2017; Snihur & Markman, 2023). Describing 'the design or architecture of the value creation, delivery, and capture mechanisms' used by a firm (Teece, 2010, p. 172), the business model concept became popular among strategy scholars about a decade and a half ago (e.g., Zott et al., 2011). Since then, it has also been widely adopted across various other academic disciplines (Massa et al., 2017). Applying the business model concept to their original phenomena of interest, scholars in disciplines like technology and innovation management (TIM) have devoted substantial attention to 'digital business models' (DBMs) that leverage digital technologies (e.g., Kohtamäki et al., 2021; Trischler & Li-Ying, 2023), whilst sustainability scholars have studied 'sustainable business models' (SBMs; e.g., Boons & Lüdeke-Freund, 2013; Dentchev et al., 2018). With the growing pervasiveness of the 'digitalization imperative' and the 'sustainability imperative' (George et al., 2021, p. 1000), these scholars finally studied the implications of the imperative that had not been on their agenda before. Thus, one stream of research started to examine the digitization of SBMs (e.g., Amaral & Orsato, 2023; Calandra et al., 2023), whilst the other turned to sustainability issues in DBMs (e.g., Di Vaio et al., 2021; Paiola et al., 2021). Although the interests of both streams began to overlap, their distinct origins left the literature fragmented. This fragmentation is particularly detrimental as strategy scholars have recently started to advance the term 'digital sustainability' to denote the application of digital technologies in organizational activities that pursue greater sustainability (George et al., 2021). These scholars immediately issued calls for empirical studies on corresponding business models (George & Schillebeeckx, 2022; Höllerer et al., 2022). As prior research on such business models is fragmented and dispersed across different academic disciplines, strategy scholars wishing to respond to these calls currently lack a consolidated body of knowledge to build upon. This situation can reduce the effectiveness and efficiency of future research on business models for digital sustainability.

To overcome this adverse situation, we conduct a systematic literature review (see e.g., Keupp et al., 2012; Tranfield et al., 2003) of existing work at the intersection of 'business models', 'digitalization' and 'sustainability'. We first define 'digital-sustainable business models' (DSBMs), before we develop a strategic management framework of DSBMs by integrating seminal characterizations of strategy research (Durand et al., 2017; Leiblein et al., 2018; Nag et al., 2007). Thereafter, we describe the established multi-coder, multi-step approach we used to identify relevant articles in leading academic journals (see Palmié et al., 2023). We subsequently synthesize the 134 articles that were identified in this way. We finally use our framework to highlight promising avenues for future research on digital-sustainable business models from a strategic management perspective.

Our comprehensive review and examination of the existing body of literature yields significant contributions to both the academic discourse and management practice. First, we develop a definition of digital-sustainable business models and a strategic management framework for their analysis. These outputs can build a common ground for strategy scholars to analyse digital-sustainable business models. Modified versions of the framework could even prove useful to scholars who want to review other topics from a strategic management perspective. Second, we leverage this framework to consolidate the fragmented research landscape. Including articles from specialty journals that strategy scholars might not read regularly, our synthesis can make them aware of insights that they would otherwise have missed. Third, the research avenues we identify based on our strategic management framework support strategy scholars in finding particularly fruitful research questions. They thus help the field move forward and provide more academically validated guidance.

CONCEPTUAL BACKGROUND

Digital transformation, sustainable development and their convergence in digital sustainability

The ongoing digitization of technology and the growing demand for sustainable development of economic

activity are 'two seemingly disparate trends' that have the power to revolutionize how firms operate (George et al., 2021, p. 999; Höllerer et al., 2022). Whilst digital technologies have already pervaded virtually all spheres of our lives, the digitization of technology continues. It comes in three manifestations—digital artefacts, digital platforms and digital infrastructures—and lays the foundation for the digital transformation of products and activities (Lanzolla et al., 2021; Nambisan, 2017). More specifically, digital transformation rests on the affordances that digital technologies entail (Lanzolla et al., 2021). Affordances denote an 'action potential or possibilities offered by an object (e.g., digital technology) in relation to a specific user (or use context)' (Nambisan et al., 2019, p. 3). Although affordances refer to the opportunity to perform new functions or existing functions more efficiently, these functions are not pre-determined by the technology but remain to be identified and developed by its users (Autio et al., 2018). Hence, 'an affordance is not a characteristic of the new technology (e.g., computing power): it is a potentiality that needs to be discovered and articulated (e.g., computer simulations to model thermal flows)' (Autio et al., 2018, p. 75).

The affordances most heavily emphasized in the foundational digital-transformation literature can be organized into three interdependent categories: (1) Representation of analogue information in digital form, possibly accompanied by the reverse transformation of digital signals into analogue actions and physical output (e.g., 3D printing, robotics); (2) changes in connections among objects and actors; (3) prevalence of combinatorial innovation (e.g., Adner et al., 2019; Autio et al., 2018; Yoo et al., 2012). The first affordance, the analogue-digital conversion, enables analysis and algorithmic manipulation. The second affordance, connectivity, facilitates the emergence of distributed innovation and disintermediation. The third affordance, combinatorial innovation, includes aggregation and generativity. Aggregation refers to 'the ability to combine previously disjoint data (e.g., location, search query and social network) to answer questions that were formerly impossible to address' (Adner et al., 2019, p. 255). Generativity refers to the 'capacity exhibited by digital technologies to produce unprompted change (through "blending" or recombination) by large, varied, unrelated, unaccredited and uncoordinated entities/actors' (Nambisan et al., 2019, p. 3). Generativity emerges from a technologically induced reduction of transaction costs, making it easy and attractive for various parties 'to engage with offerings and resources made available over the internet' (Autio et al., 2018, p. 76). Affordances entail opportunities for new business models and the revision of existing ones.

In parallel with the ongoing digitization of technology, more and more citizens, politicians and managers have grown suspicious of the conventional ways in which businesses and economies operate (Battilana et al., 2022). These ways are characterized by shareholder value maximization as the ultimate purpose of firms and an overreliance on markets' capacity to use scarce resources optimally (Pfeffer, 2010). Private consumers, organizational executives and political representatives progressively realized that these ways are not sustainable in the sense of the United Nations' so-called 'Brundtland Report'. Thus, they do not 'meet the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment & Development, 1987, p. 41) but cause long-term damage to nature's life-supporting systems and produce growingly problematic levels of social inequalities (Battilana et al., 2022; Pfeffer, 2010).

Overall, 'sustainability is a complex and contested concept without any universal agreement on a particular definition' (Banerjee, 2011, p. 719).[1] Consensus exists in three respects. First, sustainability comprises economic, social and environmental dimensions (e.g., Bansal, 2005; Elkington, 2018). Environmental sustainability is concerned with the conservation and the more efficient use of natural resources to 'lessen the burden of economic activity on the environment and [...] to ensure that the activity can be sustained over time because the resources required will not be exhausted' (Pfeffer, 2010, p. 34). Social sustainability addresses 'how organizational activities affect people's physical and mental health and well-being' (Pfeffer, 2010, p. 35). Economic sustainability designates 'an organization's impacts on the economic conditions of its stakeholders, and on economic systems at local, national, and global levels' (Global Reporting Initiative [GRI], 2016, p. 4).

Second, all three 'pillars' (dimensions) of sustainability require firms to consider the implications of their activities on a broader set of stakeholders than just their shareholders/owners. Executives of sustainable firms accommodate legitimate interests of further stakeholders in their decisions (Banerjee, 2011; McGahan, 2020). Thus, sustainability is about generating economic and non-economic value for a greater variety of stakeholders (see Barney, 2018, 2020). The extended notion of value and more involving

[1] Contributing to the complexity of sustainability is the fact that sustainability can be conceptualized at various levels of analysis, such as the firm, the industry or the national economy (Banerjee, 2011). Given the audience of the *International Journal of Management Reviews*, we primarily focus on the firm level. If the firm is placed at the centre of analysis, sustainability addresses 'the social welfare implications of business firms' (Banerjee, 2011, p. 720). Thus, even firm-centric sustainability transcends organizational boundaries and links the firm to its social and natural environment.

value creation processes open opportunities for business model innovation (Foss & Saebi, 2017; Massa et al., 2017).

Third, many scholars, political institutions and societal stakeholders believe business models are central to the transition towards greater sustainability (European Commission, 2014; Massa et al., 2017; United Nations, 2016). This conviction rests on a bipartite argument. On the one hand, the extent to which greater sustainability will be achieved is likely to depend substantially on the activities of firms and the goods and services they offer (Massa et al., 2017). On the other hand, firms are more likely to contribute to greater sustainability if they find a business model that makes this move attractive to them (Snihur & Markman, 2023).

Over time, scholars and practitioners noticed potential synergies between the twin imperatives of digital transformation and sustainability (George et al., 2021). Digital technologies can be used to create more sustainable outcomes (e.g., Etzion & Aragon-Correa, 2016; Kolk & Ciulli, 2020). This means-end relationship between digital transformation (means) and sustainable development (end) was initially highlighted in the context of smart cities, which use information and communication technology to tackle economic, environmental and social issues affecting urban spaces (Mora et al., 2019). Recently, the means-end relationship has gained currency in the broader management literature which coined the term 'digital sustainability' to designate 'organizational activities that seek to advance the sustainable development goals through creative deployment of technologies that create, use, transmit, or source electronic data' (George et al., 2021, p. 1000).

Digital-sustainable business models

Business models depict how organizations convert resources into value (Teece, 2010). The business model concept rose to prominence in the 1990s when e-commerce caused firms to introduce new ways of creating and capturing value (Zott et al., 2011). Today, academics and managers widely agree that a firm's business model belongs to the most powerful determinants of its commercial success (Snihur & Markman, 2023). Additionally, business models matter for further outcomes (Foss & Saebi, 2017; Massa et al., 2017). They affect the attractiveness of innovative solutions. Typically, firms will only profit from developing superior technologies or new product ideas if they devise appropriate business models for their commercialization (Gassmann et al., 2014; Parida et al., 2019; Teece, 2010). Business models hence influence technology evolution, innovation diffusion, industry emergence and the prosperity of product categories. They can be an engine of societal progress and help society tackle grand challenges, such as climate change and poverty (George et al., 2021; Massa et al., 2017). At the same time, technological and macro-level trends can provide organizations with ample opportunities to innovate their business models. For these reasons, business models are simultaneously driving and being driven by the 'twin transitions' of digital transformation and sustainable development.

Business models are commonly described as combinations of multiple dimensions. Whilst some descriptions split the dimensions into further categories, most descriptions comprise or can be reduced to three dimensions (as the results of our literature review below illustrate): (1) Value Proposition: What does the focal organization offer to its clients? (2) Value Creation & Delivery: How is the value proposition created and delivered to the clients? (3) Value Capture: What (economic or other) benefits accrue to the focal organization from providing its clients with the value proposition, and what (economic or other) costs does it incur by creating and delivering it? Each of these dimensions might be affected as organizations reconsider their business models in the face of sustainable development and digital transformation. Figure 1 provides some illustrative examples of how firms can incorporate the digital imperative and the sustainability imperative in the three business model dimensions.

Drawing inspiration from the smart city literature (e.g., Gassmann et al., 2019; Mora et al., 2019) and the nascent work on digital sustainability, we propose the following definition of digital-sustainable business models: *'A digital-sustainable business model uses technologies that create, use, transmit, or source electronic data in its value proposition, value creation and delivery processes, and/or its value capture mechanisms to advance sustainable development in economic, social, and/or environmental terms'*. This definition possesses three characteristics which are consistently substantiated by the articles in our sample. First, it does not require every single business model dimension to be digitalized. Instead, digital and non-digital components can coexist. Second, not every single dimension needs to emphasize sustainability. Third, digitalization and the emphasis on sustainability can occur across different dimensions. These characteristics imply that individual dimensions of a digital-sustainable business model can be identical to non-digitalized SBMs, to DBMs that do not emphasize sustainability or even conventional BMs that do not use digital technologies and do not emphasize sustainability. Indeed, the articles in our review below typically discuss business models that feature digital technologies and an emphasis on sustainability in selected dimensions.

Business models emerged as a main source of competitive advantage (Snihur & Eisenhardt, 2022; Zott et al., 2011). They have hence become a core concept of strategic management (Bigelow & Barney, 2021; Snihur & Markman,

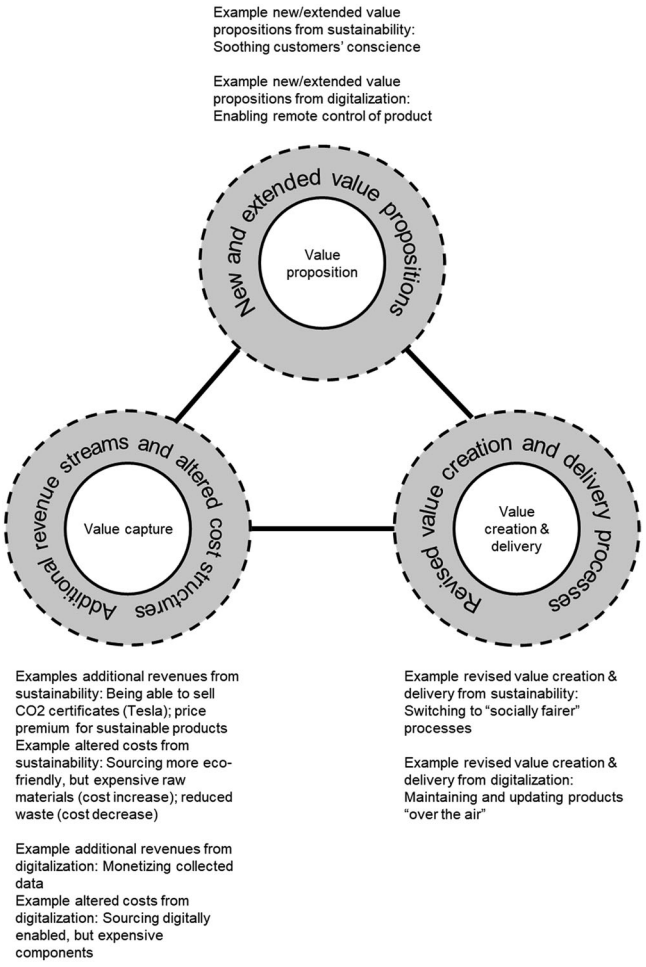

FIGURE 1 Business model dimensions with extensions for digital and sustainable business models.

2023). Some scholars depict the business model concept as a specific 'lens' for examining strategy issues (Bigelow & Barney, 2021, p. 537; Lanzolla & Markides, 2021, p. 542). According to others, the business model concept 'extends central ideas in business strategy and its associated theoretical traditions' (Zott et al., 2011, p. 1031; also, Frankenberger et al., 2013; Massa et al., 2017). Either way, the business model concept is now firmly embedded in strategic management theory and practice (Foss & Saebi, 2017; Teece, 2010). It is, therefore, paramount to study this concept from a strategic management perspective. We will next develop a strategic management framework for our subsequent analysis.

A strategic management framework of digital-sustainable business models

The field of strategic management emerged in the late 1970s and subsequently developed into a core discipline of management science (Durand et al., 2017; Nag et al., 2007). Over the course of its existence, it has dealt with a variety of topics and phenomena (Hoskisson et al., 1999; Nag et al., 2007). Early on, it focused on market- and industry-level factors to explain a firm's competitive position (e.g., Porter, 1980), before it started paying more attention to firm-level determinants of competitive advantage (e.g., resources; Barney, 1991) and most recently turned to individual-level explanations of inter-organizational heterogeneity (e.g., action and interaction of employees; Foss, 2011). Amid the diversity of topics and phenomena addressed, it became increasingly difficult to pinpoint the distinctive nature of the strategy field, resulting in a multiplicity of definitions of what strategic management is (Nag et al., 2007). To overcome this unsatisfactory situation, several scholars recently sought to unveil the characteristic features of strategic management. First, surveying over 250 management scholars and coding about 400 academic articles, Nag et al. (2007) identified seven constituting elements of the strategy field. According to their resulting 'consensus definition', strategic management consists of (a) the major intended and emergent initiatives, (b) the internal organization adopted, (c) by general managers on behalf of owners, (d) involving utilization of resources, (e) to enhance the performance, (f) of firms, (g) in their external environments.

Second, Durand et al. (2017) observed some 'unifying beliefs' (p. 7) that most strategy research shares, notwithstanding the wide variety of topics and phenomena covered. These beliefs include: (a) organizations (especially, business firms) represent the primary focus of analysis, (b) organizations differ from one another, (c) such inter-organizational heterogeneity leads to differences in proximal and distal outcomes[2]; (d) it is worth exploring the origins of such inter-organizational heterogeneity (Durand et al., 2017, p. 7).

Third, Leiblein et al. (2018) attempted to integrate the strategy field by illuminating the nature of strategic decisions. According to this account, strategic decisions possess three unique characteristics: (a) strategic decisions are interdependent with other contemporaneous decisions of the focal economic actor, (b) they are interdependent with decisions of other economic actors (such as competitors, suppliers or buyers), (c) they are interdependent with other decisions of the focal actor across time. Leiblein et al. (2018) subsequently proposed that 'strategic management is the study of how decisions that embody these three fundamental properties of decision interdependence

[2] Examples of proximal (or intermediary) outcomes are legitimacy, innovativeness and the development of organizational capabilities. Examples of distal outcomes are a firm's competitive advantage and financial performance (Durand et al., 2017; Palmié et al., 2023).

are unveiled, framed, considered, evaluated, made, and implemented' (p. 559).

We integrate these seminal articles to develop a framework for our literature review. This strategic management framework of digital-sustainable business models consists of four elements. The first element represents the focal organization—specifically, its business model—which is placed at the centre of analysis (see Durand et al.'s point (a) and Nag et al.'s point (f) above). The second element represents contemporaneous decisions, initiatives and other distinct features of the focal organization that are interdependent with its business model (see Durand et al.'s point (b), Leiblein et al.'s point (a) and Nag et al.'s points (a)–(d) above). This element also covers contemporaneous decisions of other actors in the organizations' environment (see Leiblein et al.'s point (b) and Nag et al.'s points (g) above).

The third element and the fourth element account for interdependencies across time (see Leiblein et al.'s point (c) above). The third element represents past decisions and existing features of the focal organization and its environment that affect its business model. In other words, it represents the antecedents of the business model (see Durand et al.'s point (d) above). The fourth element represents the proximal and distal outcomes of the focal business model (see Durand et al.'s point (c) and Nag et al.'s points (e) above). Figure 2 depicts our framework graphically. This framework will help us organize the reviewed literature.

METHODOLOGY

To integrate research on the digitalization of sustainable business models and research on sustainability considerations of digital business models, we conduct an integrative literature review (see Callahan, 2010; Palmié et al., 2023; Torraco, 2016). Integrative literature reviews are 'a form of research that reviews, critiques, and synthesizes representative literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated' (Torraco, 2005, p. 356).

As a special kind of systematic literature review, an integrative literature review begins with the systematic selection of relevant and representative literature in the chosen field of research (Tranfield et al., 2003). Peer-reviewed journal articles are commonly argued to represent 'validated knowledge' and to have the greatest impact in their respective fields (Keupp et al., 2012, p. 369). In line with the vast majority of articles in dedicated review outlets like the *International Journal of Management Reviews*, we therefore restrict ourselves to peer-reviewed articles, whilst omitting books, book chapters and other non-refereed publications (Hutzschenreuter & Israel, 2009; Nielsen, 2010). Moreover, review articles frequently focus on a pre-selected set of prominent journals rather than covering all peer-reviewed journals (see Keupp et al., 2012). Prominent journals tend to shape the theoretical and empirical work in a field by determining the 'horizons for inquiry' (Furrer et al., 2008, p. 2). Our study also adopts this established focus but relaxes it in a crucial way to include the most impactful articles. In addition to articles in leading journals, our review covers 'highly cited papers' and 'hot papers' (as designated by the Web of Science) published outside the leading journals. If articles are cited heavily, they shape the academic discourse, irrespective of their source. Including highly cited and hot papers is therefore consistent with the reasoning for focusing on leading journals. The articles for our review were selected along the steps outlined in Palmié et al. (2023). Figure 3 summarizes our procedure.

First, we perused Scopus and the Web of Science to identify articles that simultaneously contain terms related to (a) 'business models', (b) 'sustainability' and (c) 'digitalization' in their title, abstract and/or keywords. The literature search, which did not specify a start or end date, was conducted between March and June 2023. The employed search terms are (a) 'business model', 'value creation', 'value capture', 'value delivery' and 'value proposition'; (b) 'sustainability', 'sustainable', 'circular', 'environmental', 'environment', 'ecological', 'eco-', 'green', 'social', 'sharing', 'climate', 'pollution', 'shared value' and 'public value'; and (c) 'digital', 'digitization', 'digitalization', 'Industry 4.0', 'information and communication technology', 'ICT', 'analytics', 'connected', 'smart', 'data technologies', 'artificial intelligence', 'AI', 'online', 'additive manufacturing', 'augmented reality', 'extended reality', 'virtual', 'automation', 'big data', 'blockchain', 'cloud computing', 'internet', 'robotics', 'semantic technologies' and 'simulation'. Spelling variations of these terms (e.g., 'digitalization' and 'digitalization'), singular versus plural numbers (e.g., 'business model' and 'business models') and adjective versus adverb forms (e.g., 'environmental' and 'environmentally') were also considered. Our search covered a variety of articles and journals. First, we turned to the 2021 Academic Journal Guide (AJG) of the Chartered Association of Business Schools (ABS), commonly referred to as the 'ABS list' (see Rabetino et al., 2021). Our search covered all journals that are rated at 3, 4 or 4* in the following categories of the 2021 ABS list: 'Entrepreneurship and Small Business Management'; 'General Management, Ethics, Gender and Social Responsibility'; 'Information Management'; 'Innovation'; 'Operations and Technology Management'; 'Organisational Studies'; 'Social Sciences' and 'Strategy'. These categories represent those sub-disciplines on the ABS list that are most likely to deal with issues related to business models, sustainability and digitalization. Across the selected categories, ABS AJG 2021 contains a total of

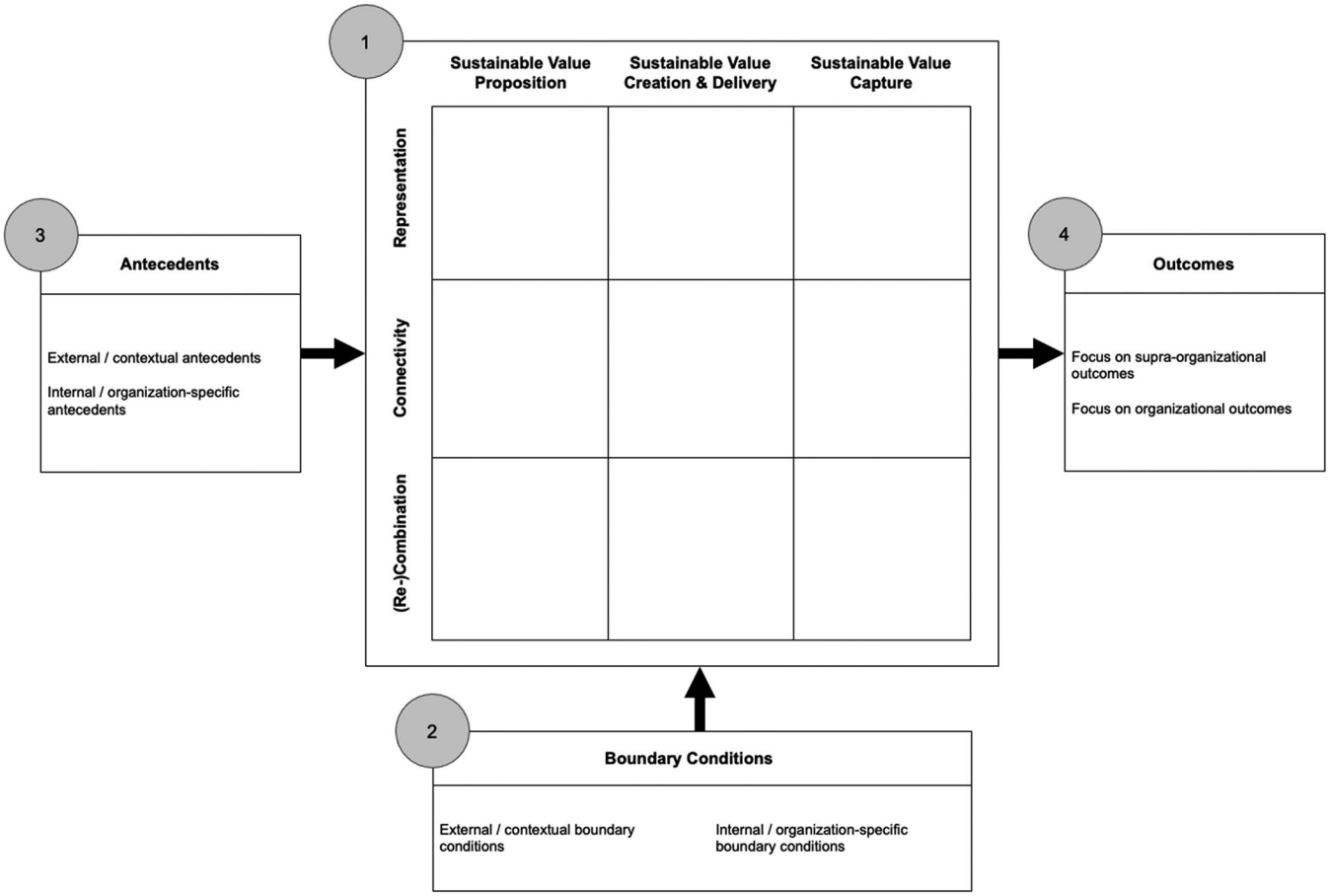

FIGURE 2 Strategic management framework of digital-sustainable business models.
Note: The numbers in grey circles refer to the elements' ID in the text.

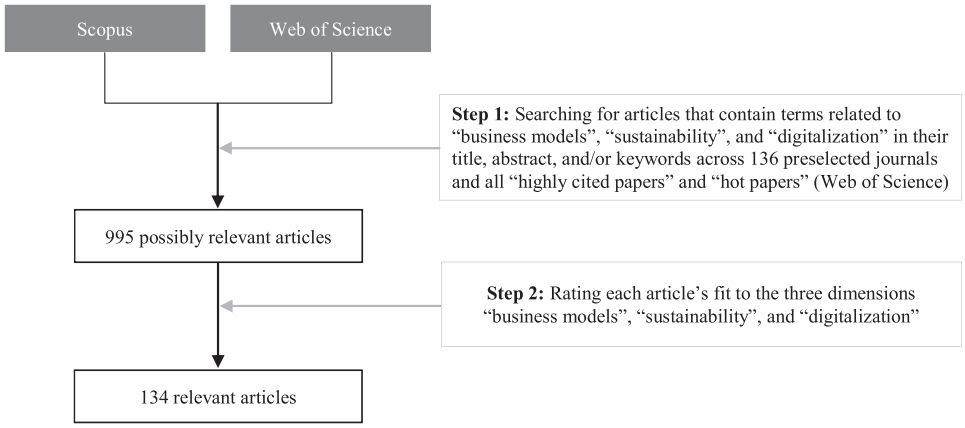

FIGURE 3 Article selection process.

121 journals with a rating of 3 and above. Second, we considered the category 'Sustainability Management' on the current journal quality list (VHB-JOURQUAL3) of the German Academic Association of Business Research (VHB). We included VHB-JOURQUAL3 in addition to the ABS list because the former contains a dedicated category for sustainability management, whilst the latter does not. In analogy to our procedure with the ABS list, our search comprised those 15 journals in the 'Sustainability Management' category that are rated at B, A or A+ according to VHB-JOURQUAL3. Third, our search captured 'highly cited papers' and 'hot papers' in the Web of Science that

feature the above search terms, irrespective of the journal they appeared in. Together, the inquiries provided us with 995 possibly relevant articles.

Second, each of the 995 articles that emerged from Step 1 was independently rated by two researchers—with at least one of the two ratings coming from one of the co-authors—according to the extent to which it deals with (a) business models, (b) sustainability and (c) digitalization, based on the understanding of the terms outlined above. These extents were measured by 4-point scales, with 1 indicating a very low extent (not at all) and 4 indicating a very high extent (perfect representation) (see Keupp et al., 2012; Nag et al., 2007). If an article was rated 3 or 4 in all three dimensions (business model/sustainability/digitalization) by both raters, it was used for the subsequent analysis. If it was rated 1 or 2 in at least one dimension by both researchers, it was not used in the subsequent analysis. If an article was rated 3 or 4 by one rater and 1 or 2 by the other in the same dimension(s), another co-author also rated the article. The article was then considered relevant for the subsequent analyses if it achieved an average rating of 2.5 or higher across the three raters in each of the three dimensions. It was deemed irrelevant if its average rating was below 2.5 in at least one dimension. Based on this procedure, a total of 134 articles were considered relevant and retained for the subsequent analysis.

These 134 articles are considered as representing the state-of-the-art research on business models for digital sustainability and are analysed subsequently. The 134 articles considered in our literature review are indicated by an asterisk (*) in the reference list.

FINDINGS

This section provides a descriptive account of the reviewed articles and is structured as follows. First, it shows where the reviewed articles were published and when. It then reveals how the articles conceptualize business models before it elaborates on the theories and methods they used. Finally, it presents how they operationalize digitalization and sustainability, respectively, and how they address the relationship between digitalization and sustainability.

Distribution of the reviewed articles over time and across journals

The reviewed articles first examined business models in the context of digitalization and sustainable development in 2007. The number of related publications took off in 2018, with most articles (37; 28%) being published in 2021,

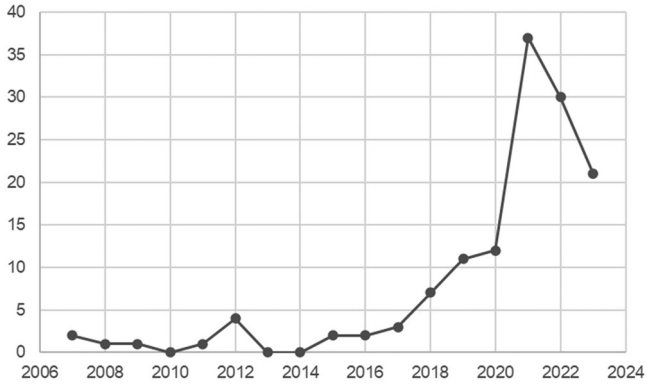

FIGURE 4 Number of articles across time.

indicating a growing interest in the research area in recent years (Figure 4).

Analysis of the publication outlets (Table 1) shows that the majority of the reviewed articles are published by four specialty journals in the sustainability domain—*Technological Forecasting and Social Change* (23 papers; 17%), the *Journal of Cleaner Production* (17 papers; 13%), *Business Strategy and the Environment* (17 papers; 13%) and *Energy Policy* (11 papers; 8%). General management journals published fewer articles. A notable exception is the *Journal of Business Research*, which published 10 articles (7%). *Technovation* and *Government Information Quarterly* published 6 (5%) and 4 (3%) articles, respectively. Dedicated strategy journals, such as the *Strategic Management Journal*, *Strategy Science* and *Long Range Planning*, are completely absent. This distribution of outlets suggests that digital-sustainable business models have rarely been studied from a mainstream management perspective and that, consequently, general/strategic management theory on digital-sustainable business models might be underdeveloped.

Business model conceptualizations

Only 59 of the 134 articles (44%) delineate their understanding of the term 'business model'. According to the most commonly used conceptualization, a business model consists of three components (dimensions): (1) value proposition, (2) value creation and delivery and (3) value capture. Eighteen of the 59 articles (31%) conceptualize business models in this way, typically citing Osterwalder and Pigneur (2010), Richardson (2008), Bocken et al. (2014) and/or Teece (2010) as the source(s) of their understanding. Twenty-six additional articles offer conceptualizations comprising two of the three mentioned components. Three more articles refer to the nine-component conceptualization of Osterwalder and Pigneur's (2010) Business Model

TABLE 1 Number of articles by journal.

Journal	Abbreviation	Number of articles
Technological Forecasting & Social Change	TFSC	23
Business Strategy and the Environment	BSE	17
Journal of Cleaner Production	JClP	16
Energy Policy	EnPol	14
Journal of Business Research	JBR	10
Technovation	Technovation	6
Government Information Quarterly	GIQ	4
Information Systems Journal	ISJ	3
Organization & Environment	OAE	3
Sustainability	Su	3
Information & Management	I&M	2
International Journal of Production Research	IJPR	2
Production and Operations Management	POM	2
Supply Chain Management: An International Journal	SCM	2
Business & Society	BAS	1
Computers in Human Behaviour	CHB	1
Computers in Industry	CI	1
California Management Review	CMR	1
International Journal of Energy Sector Management	IJESM	1
International Journal of Operations & Production Management	IJOPM	1
International Journal of Production Economics	IJPE	1
International Small Business Journal	ISBJ	1
Information Systems Frontiers	ISF	1
Information Technology & People	ITP	1
Journal of Business Ethics	JBE	1
Journal of Environmental Management	JEM	1
Journal of Industrial Ecology	JIE	1
Journal of Management Information Systems	JMIS	1
Journal of Manufacturing Technology Management	JMTM	1
Journal of the Science of Food and Agriculture	JSFA	1
Journal of Strategic Information Systems	JSIS	1
Journal of Sustainable Tourism	JST	1
Journal of World Business	JWB	1
Manufacturing and Service Operations Management	MSOM	1
Maritime Policy & Management	MPM	1
MIS Quarterly	MISQ	1
Production Planning and Control	PPC	1
Resources, Conservation & Recycling	RCR	1
Small Business Economics	SBE	1
Social Science & Medicine	SSM	1
Transportation Research Part A: Policy and Practice	TRA	1
Total		134

TABLE 2 Association between the three- and the nine-component conceptualizations of business models.

Three components	(A) Value proposition	(B) Value creation & delivery	(C) Value capture
Nine components	(1) Value propositions (2) Customer segments (3) Customer relationships	(4) Key activities (5) Key resources (6) Key partners (7) Channels	(8) Cost structure (9) Revenue streams

Note: Based on Osterwalder and Pigneur (2010) and Richardson (2008).

Canvas, which can be mapped onto the three-component conceptualisation above (as depicted in Table 2). In sum, 80% of the articles explicating their understanding of the term 'business model' (47 of 59 articles) use a multi-component conceptualization in line with the three components above. Five articles use a divergent multi-component conceptualization, whereas only seven of the 59 articles (12%) use a single-component conceptualization. Because of its broad appeal, we chose the three-component conceptualization to examine the business models presented in the selected articles.

Theories and methods applied in the reviewed articles

Less than half the articles, 59 (44%), explicitly referred to a theory they applied in their study. Table 3 presents an overview of the theories used. Most frequently mentioned are stakeholder theory (10%), service-dominant logic (10%), institutional theory (8%) and the resource-based view (8%). It is surprising that theories from the information system (IS) discipline, such as the technology acceptance model, the IS success model and the technology affordance theory, are rarely used (in one article each) even though digitalization is the core focus of the IS discipline.

Most of the reviewed papers (53%) use qualitative research methods, including case studies, interviews and observations (Table 4). 15% of the papers are literature reviews. 14% of the papers apply mixed methods, with the majority using mixed methods without a quantitative element. Quantitative research methods are underrepresented, being adopted by only 6% of the reviewed articles. 9% of the articles pursue a purely conceptual approach and the remainder of the studies (3%) apply simulation/mathematical modelling methodologies. Analysis of the applied methods reveals that, at the present time, we know considerably little about the interdependencies and relationships among multiple constructs with digital-sustainable business models. Currently, the research community focuses on qualitative approaches to explore individual concepts in detail.

Operationalizations of digitalization and sustainability

Table5 presents an overview of how often specific digital technologies are being investigated in the selected sample. Most of the reviewed articles focus on such technologies as the Internet of Things (including RFID in smart products), big data, blockchain and artificial intelligence. Cloud computing, mobile apps and connectivity technologies received much less attention. Notably, augmented reality (AR) and virtual reality (VR) are mentioned only in a few articles (4), which seems at odds with the growing popularity of remote work in the post-Covid era.

To measure and operationalize sustainability, most articles focus on aspects of environmental sustainability, looking at resource consumption, resource flows (recycling), CO_2 emissions and renewable energies. Food waste is also mentioned occasionally (Amaral & Orsato, 2023; Ciccullo et al., 2022). Fewer articles focus on aspects of social sustainability, such as access to education, affordable housing, public health and social care, or social cohesion. Only one article (Gössling & Michael Hall, 2019) studies economic sustainability apart from the financial performance of the focal firm(s).

Synergies and tensions between digitalization and sustainability

From our sample of 134 articles, 132 highlight the benefits of digitalization for sustainability. Thereof, 71 articles (54%) present some form of evidence for the existence of these synergies. However, the level of empirical validity varies, with some studies providing only weak evidence. The other 61 articles state expectations of potential co-benefits. The two exceptions are Shankar et al. (2022), who only focus on the negative impacts of digitalization on sustainability, and Song (2019), who investigates how the digital entrepreneurial ecosystem can become more sustainable.

Tensions or trade-offs between digitalization and sustainability are highlighted by 30 articles, whereof seven articles include empirical evidence for such tensions.

TABLE 3 Theories used.

Theory/ framework	Times mentioned
Stakeholder theory	6
Co-creation/ service-dominant logic	6
Institutional theory	5
Resource-based view/ knowledge-based view	5
Contingency theory	3
Transaction-cost economics	3
Practice-based view	2
Dynamic capabilities	2
Resource orchestration theory	2
Multi-level perspective	2
Microfoundations	2
Disruptive innovation	1
Legitimacy theory	1
Collective action theory	1
Digital activism concept	1
Network effects	1
Contract theory	1
Moral foundations theory	1
Platform economics	1
Unified theory of acceptance and use of technology (UTAUT)	1
Blockchain governance framework	1
Theory of planned behaviour	1
Actor-network theory	1
Technology affordance theory	1
Game theory	1
Economies of scale	1
Framing	1
Open innovation	1
Ecological modernization theory	1
IS success model	1
Resilience theory	1
Transition theory	1
Total	59

TABLE 4 Methods used.

Method	Number of times used	Share
Qualitative	71	53%
Literature review	20	15%
Mixed method	19	14%
Conceptual	12	9%
Quantitative	8	6%
Mathematical modelling/simulation	4	3%
Total	**134**	**100%**

TABLE 5 Specific technologies investigated.

Digital technology	Number of articles
Internet of Things (IoT)	39
Digital platforms	28
Big data, big data analytics	23
Blockchain	21
ICT	21
Artificial Intelligence (AI)	15
Smart meters, smart grids	15
Internet	12
3D printing/ additive manufacturing	10
Cloud computing	8
Robotics and automation	4
Cyber-physical systems	3
Augmented reality (AR) and virtual reality (VR)	2
Fintech	2
Virtual power plants	2
Digital twins	1
Precision agriculture	1

TABLE 6 Distribution of digitalization and sustainability foci across business model components.

	Digital	Sustainable
Value proposition	84 articles	87 articles
Value creation & delivery	121 articles	115 articles
Value capture	61 articles	64 articles

Thus, digitalization's potential negative impacts on sustainability are not playing a major part in the present research.

Distribution of studies across the elements of our strategic management framework

Figure 5 shows how the content of the analysed articles is spread across the elements of the strategic management framework that we developed in the conceptual background section. In terms of this framework's central element, business models as such, Figure 5 highlights that the three BM dimensions have been covered to different degrees. Table 6 refines this observation. Figure 5 and Table 6 jointly reveal that most articles in our sample discuss digitalization and sustainability with respect to value creation and delivery processes, whereas the value capture dimension is least frequently analysed from both perspectives. The value proposition falls between these extremes.

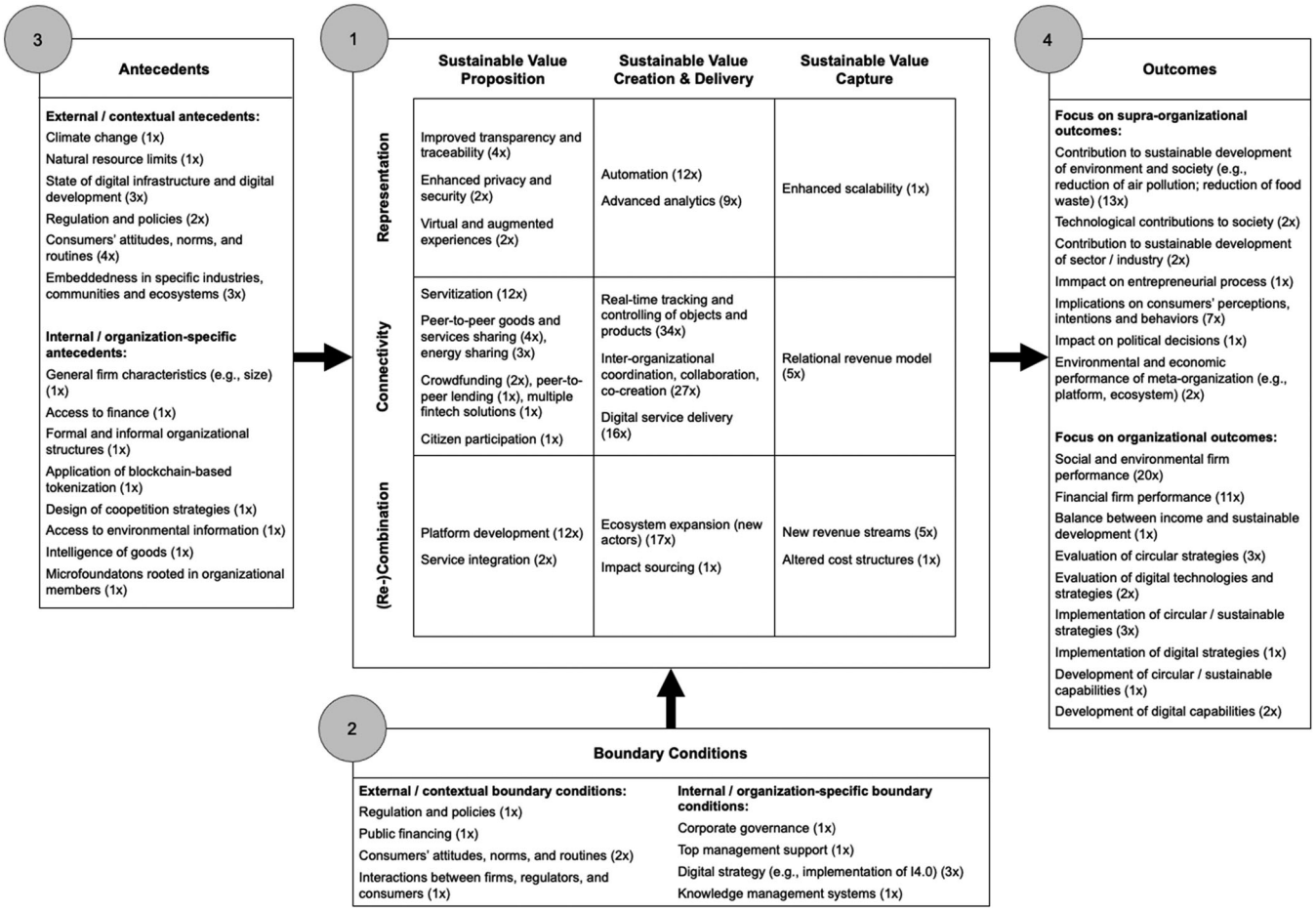

FIGURE 5 Strategic management framework of digital-sustainable business models with results from literature review.

These findings illustrate that not all BM dimensions need to be digitalized or need to emphasize sustainability to transform a BM into a DSBM.

Figure 5 further indicates that the three digital affordances have been covered to different degrees. Most articles in our sample deal with business models that leverage connectivity, whereas business models related to (re-)combination and representation have received less attention to date. Turning to the other elements of our strategic management framework, Figure 5 shows that scholars have started to investigate external (contextual) and internal (organization-specific) boundary conditions for DSBMs. However, research on both types of boundary conditions is still rare. Compared to boundary conditions, a greater but still moderate number of articles in our sample has studied antecedents of DSBMs, which can likewise be distinguished into external (contextual) and internal (organization-specific) factors. Whilst the literature on external antecedents of DSBMs is far from being saturated, Figure 5 illustrates that some external antecedents have been covered repeatedly. In contrast, cumulative findings with respect to internal antecedents are so far completely missing. Finally, Figure 5 indicates that both supra-organizational and organizational outcomes have been studied quite extensively in the reviewed literature, being investigated more frequently than antecedents and boundary conditions combined. Building on the findings synthesized in Figure 5, the following section identifies crucial knowledge gaps and suggests fruitful paths for future research.

AN AGENDA FOR FUTURE RESEARCH ON DIGITAL-SUSTAINABLE BUSINESS MODELS FROM A STRATEGY PERSPECTIVE

This section is structured according to the elements of our framework. It first discusses the business model elements. It then tackles boundary conditions before it turns to the antecedents. Finally, it elaborates on the outcomes of digital-sustainable business models.

Paths for future research with respect to business model components

The following subsections will each first delineate how the focal BM dimension can be transformed for greater sustainability. They will then discuss how digital affordances can enable this transformation before they identify some paths for future strategic management research. An overarching opportunity for further work emerges from the fact that almost all of the reviewed articles assume positive implications of digitalization for sustainability, but very few articles present strong empirical evidence for these benefits (see Section 4.5 above). We need efforts that validate, refute or qualify this widespread assumption empirically.

Sustainable value proposition

Since value propositions traditionally centre around products, making products more sustainable is a prime way to arrive at more sustainable value propositions. The articles in our sample reveal three main ways in which products can become more sustainable: By utilizing more sustainable (e.g., recycled) materials (Massaro et al., 2021), by using more sustainable technologies for product functions (e.g., electric drives instead of internal combustion engines in cars; Gómez San Román et al., 2011), and by using more sustainable production methods (e.g., foregoing hazardous chemicals and implementing fair working conditions; Abbate et al., 2023a). Whilst the reviewed articles present these different ways of making products sustainable, each article tends to focus on one of these ways. From a strategic management perspective, it would be intriguing to compare the different ways systematically. Under which conditions is which way particularly promising? Do the different ways benefit from different commercialization strategies? Which way yields the strongest outcomes in terms of the triple-bottom line?

Increasingly, companies are shifting away from a product focus to offering use- or performance-oriented product-service systems (PSS) that prioritize providing customers with access to goods over outright ownership (product-as-a-service, servitization). With PSS, product ownership—and, consequently, the responsibility for products during and beyond the use phase—remains with the provider (Pirola et al., 2020). This shift enables and incentivizes firms to control their products throughout the life cycle, to extend product lifetimes and to close the loop (Chauhan et al., 2022). Prioritizing the possibility of use over ownership further creates opportunities for asset sharing and collaborative consumption, which can yield smaller environmental footprints. Sharing products with other customers increases the utilization rate of the individual product unit so that fewer units need to be manufactured in the first place (Liu et al., 2022; Tan & Salo, 2023). However, asset sharing can cause rebound effects (Palmié et al., 2021). Collaborative consumption can be less expensive for the user than owning the product, leaving consumers with more disposable income that they might spend on environmentally damaging activities (Kjaer et al., 2019). Similarly, if sharing arrangements make ecologically harmful products accessible to consumers who have not use them before, the environmental footprint of these products also increases. Thus, asset sharing is not sustainable per se. Scholars should investigate how firms can minimize the risk of rebound effects and what complementary strategies secure or increase the sustainability of sharing propositions.

Value propositions around social sustainability, such as healthcare services (Oderanti et al., 2021; Palas & Bunduchi, 2021) or services for the 'bottom of the pyramid' (Sengupta et al., 2021), have received significantly less attention from the reviewed articles than value propositions related to environmental sustainability. We encourage management scholars to examine how the strategies promoting social sustainability differ from strategies seeking environmental sustainability.

Digital affordances enabling sustainable value propositions

Digital affordances allow for new possibilities of integrating products with services (Pirola et al., 2020). The affordance of representing analogue information in digital form enables firms to offer new services and additional benefits to their customers. For instance, blockchain and RFID technologies can afford the integration of improved transparency and traceability into the value proposition (Abbate et al., 2023a). Since customers may otherwise doubt if allegedly sustainable products live up to their claims, these improvements can be advantageous from a sustainability perspective. Alternatively, blockchain technologies can afford enhanced privacy and security which can contribute to greater social sustainability, for instance, in the healthcare sector (Palas & Bunduchi, 2021). Further, adding virtual (Alshawaaf & Lee, 2021) and augmented (Cranmer et al., 2021) experiences can increase the attractiveness of sustainable value propositions.

The connectivity affordance enables firms to track and monitor their products throughout the life cycle, supporting servitization (PSS) business models that help unlock the transition towards the circular economy (Chauhan et al., 2022; Pirola et al., 2020). Similarly, IoT technologies and their connectivity can improve energy efficiency (e.g., smart homes with connected devices; Del Rio et al.,

2020) and facilitate the operation of peer-to-peer trading platforms (Brown et al., 2019; Menzel & Teubner, 2021). The affordance of combinatorial innovation can also support sustainable value propositions. As digitalization has substantially reduced the costs of transactions between companies in nearly all industries, it enables the realization of sustainable customer journeys at lower costs (Gassmann & Ferrandina, 2021). Moreover, various players develop and promote sustainability-related platforms for purposes like prosocial crowdfunding or peer-to-peer lending (Jancenelle & Javalgi, 2018; Ravishankar, 2021). Besides supporting the creation of new, value-adding services, the recombination and integration of disparate services can yield greater sustainability by improving resource efficiency (Del Rio et al., 2020; Qi & Shen, 2019).

Looking at the specific technologies that are analysed in the reviewed articles (see Table 5), it seems striking that augmented reality (AR), virtual reality (VR) and digital twins receive quite little attention. This research gap is problematic given the alleged potential of the industrial metaverse and the growing popularity of remote work in the post-pandemic era (Ashforth et al., 2024). We, therefore, call for more research that analyses value propositions around these technologies.

Even relatively frequently studied technologies offer ample opportunities for future work. An example is artificial intelligence (AI) in terms of better prediction models: What are the effects of better-knowing consumer preferences through AI on return rates in retail? How can AI better predict people's behaviour and optimize housing, mobility, energy consumption and transactions? Generative AI is another example. Since OpenAI released its Generative Pre-trained Transformer 3.5 (GPT-3.5), many use cases of generative AI models have been discussed, but their implications for sustainability are not clear yet. Whilst training the underlying models requires huge amounts of energy, there is a lack of research regarding their potential for and overall effect on sustainability.

Several interesting questions in the strategic management domain deserve further consideration: How do companies decide which sustainable value proposition they want to offer, which digital affordances they will invoke, and which digital technologies they intend to leverage? Firms may start with identifying a value proposition they want to offer and then search for the most suitable technology, or they may have a digital technology in mind (or at hand) and look for a value proposition that allows them to reap the most returns from this technology. How do opportunities and challenges differ across these approaches? What differences emerge in the competitive strategies with which various value propositions can be successfully commercialized? Are there complementarities or rivalries between multiple value propositions (e.g., in the required resources and competencies or in the suitable competitive strategies)? Answering this latter question will provide scientific insights that support firms in optimizing their portfolio of goods and services.

Related questions pertain to the industry or industries in which a specific company intends to be active. Several articles in our sample focus on organizations from the energy sector, studying solar home systems (Bisaga et al., 2017), smart homes (Del Rio et al., 2020), or energy communities (Iazzolino et al., 2022). Can insights from the energy sector be generalized to other industries? A comparative analysis across different industries and contexts can help identify significant similarities and differences in creating sustainable value propositions with the assistance of digital technologies.

Sustainable value creation and delivery

The sustainability of value creation and delivery can be increased by implementing circular economy (CE) practices (Palmié et al., 2021). Examples of CE practices highlighted by the articles in our sample include the use of renewable materials and dematerialization to reduce resource consumption (Abbate et al., 2023a; Ford et al., 2021), the reuse of materials and components through remanufacturing (Chauhan et al., 2022), and the implementation of closed-loop supply chains to minimize waste generation (e.g., Chaudhuri et al., 2022; Okorie et al., 2021).

Digital affordances enabling sustainable value creation and delivery

Many of the reviewed articles illustrate how the affordance of representing analogue information in digital form enables greater sustainability through automation and advanced analytics. For example, Rubio et al. (2021) show how robots, autonomous guided vehicles (AGVs) and automation can reduce the energy consumption in manufacturing, whilst El-Haddadeh et al. (2021) examine how the adoption of big data analytics can be used to address societal challenges.

Together with the representation affordance, the connectivity affordance supports digital service delivery, promoting social sustainability (e.g., healthcare services; Ringvold et al., 2023; Srivastava & Shainesh, 2015). Further, the connectivity affordance enables real-time tracking and controlling of objects and products. For example, blockchain affords the adoption of reverse logistics activities in sustainable food supply chains (Kazancoglu et al., 2023). Further, RFID and similar sensors embedded in products can be used by firms to capture more precise consumption data and real-time information on the products'

condition and wear, advancing sustainability by enabling improved life cycle analyses and predictive maintenance (Chavez et al., 2023; Oghazi et al., 2018; Toth-Peter et al., 2023).

Solutions like predictive maintenance and data-driven process automation are made possible by the representation affordance in conjunction with the connectivity affordance. Smart objects use their connection through the Internet of Things to transmit the digitally represented information about their status quo to a focal organization. From a strategic management perspective, this symbiosis of multiple affordances raises interesting questions: What interaction effects exist between the diverse affordances and which strategies enable companies to leverage complementarities? Digital technologies can further improve communication, information exchange, monitoring, transparency and collaboration across organizational boundaries—with potentially positive implications for the environmental footprint of value creation and delivery (Abbate et al., 2023a; Panagiotopoulos et al., 2012; Unterfrauner et al., 2019). Likewise, the interplay between the representation and the connectivity affordances can contribute to the creation of social value. For instance, blockchain applications (e.g., smart contracts) can reduce the risks and intermediation costs of social crowdfunding platforms by increasing trust and transparency (Nguyen et al., 2021), so that the potential benefits of crowdsourcing platforms for social (and environmental) sustainability can be realized to a greater extent. A prominent topic in the reviewed article with respect to inter-organizational connectivity concerns how digital platforms can enable ecosystem coordination and collaboration (Blackburn et al., 2023). A relatively large number of studies have investigated how firms can establish and orchestrate digital platforms (e.g., Cui et al., 2022; Reuter, 2022). In contrast, few studies analyse how companies align themselves with and join existing platforms (Miehé et al., 2023). This imbalance is problematic, since platforms typically possess a small number of orchestrators (if any) and a greater number of complementors. Most firms will hence probably be complementors (join an existing platform) rather than orchestrators (establish their own platform). Future research should resolve this imbalance by investigating complementor business models in greater detail.

In sum, there are two distinct facets to the connectivity affordance of digital technologies: For one thing, digital technologies connect smart objects with a focal organization (and other smart objects belonging to the same organization, respectively). For another thing, digital technologies can help facilitate exchange and coordination across organizational boundaries (Lee & Trimi, 2021; Massaro et al., 2021). The two-faced nature of the connectivity affordance invites future research on how companies choose among or combine both facets.

By allowing new actors—such as prosumers (Menzel & Teubner, 2021), makers (Unterfrauner et al., 2019), or citizens (Bencsik et al., 2023)—to join ecosystems, digital technologies also afford combinatorial innovation. New actors bring their ideas, competencies and resources to the ecosystem and can either combine diverse inputs from the ecosystem into novel outputs themselves or provide other ecosystem members with additional inputs that the other members can then utilize to generate new goods and services. Similarly, digital technologies can enable actors that were already involved in the ecosystem before to assume new roles or new tasks, thereby bringing novel ideas, competencies and resources to the ecosystem. A prominent example stems from the energy sector, where consumers have started to act as electricity producers, becoming 'prosumers', which enabled firms to device novel business models for the energy transition (e.g., Virtual Power Plants [Brown et al., 2019; Palmié et al., 2021]).

The digitalization of value creation and delivery processes requires appropriate resources. The key role of resources is addressed in many articles (e.g., Alcayaga et al., 2019; Amat-Lefort et al. 2020; Dahmani et al., 2021). However, less than a handful of articles have addressed an important type of intangible resource: organizational capabilities. Notable exceptions study the capabilities that SMEs pursuing sustainability objectives need to adopt digital technologies (Chaudhuri et al., 2022), and the capabilities firms implementing a digital business model need to become more sustainable (Paiola et al., 2021). We encourage future research to complement and extend these initial efforts on organizational capabilities for integrating digitalization and sustainability. For example, by utilizing complementarity theory (Brynjolfsson & Milgrom, 2013) future research in strategic management can seek to understand how organizations can synchronize their various intangible resources. Moreover, more studies are required to investigate corporate governance structures, performance evaluation systems and incentive mechanisms related to digital and sustainable value creation within firms.

Employees typically play a major role in developing organizational capabilities (Helfat & Martin, 2015). The strategy literature points out that fundamental changes—such as the changes induced by the digitalization of value creation processes—can easily bring about employee resistance (e.g., Herrmann & Nadkarni, 2014). However, the articles in our sample shed little light on issues related to employee resistance, how top management support can overcome this resistance, and how to reduce the gap between company vision and execution. This gap could be a fruitful area for additional research.

Sustainable value capture

The sustainability transformation can change revenue streams and cost structures. Some articles point to opportunities for new revenue streams, such as selling used products (Haftor et al., 2021) or becoming a prosumer (Brown et al., 2019). Reusing components and materials, reducing waste and energy consumption, and managing products across the life cycle can yield lower costs (Schwanholz & Leipold, 2020; Toth-Peter et al., 2023). At the same time, reverse logistics, recycling, repurposing and the safe disposal of waste can incur additional expenditures (Chavez et al., 2023; Hong et al., 2022). Future research should provide a more nuanced understanding of these opposite effects.

It would be interesting to broaden the value capture dimension from economic value to economic, social and environmental value. Creating social and environmental value represent external effects from the perspective of the focal firm (Hietschold et al., 2023). How can these external effects be internalized so that a firm is more motivated to create social and environmental value? What are the mechanisms for including social and environmental externalities in sustainable value capture? Studying these questions seems like a fascinating endeavour for future work.

Digital affordances enabling sustainable value capture

Digitalization and the affordance of representing analogue information in digital form can be used to improve transparency, traceability, analytics and automation, which can enable efficiencies, cost reductions and additional revenues (Calabrese et al., 2023; Shomali & Pinkse, 2016). Besides economic benefits, the representation of analogue information in digital form offers enhanced scalability of socio-environmental value (Gregori & Holzmann, 2020). Again, these effects of the representation affordance can be strengthened by leveraging the connectivity affordance of digital technologies. Connectivity supports the transmission of real-time data coming from RFID and other digital sensors, which add to traceability and offer further opportunities for analytics. Since some customers value better traceability and analytics, the connectivity affordance can often be monetized. Similarly, the provider of a digitally enhanced product might use the connectivity affordance to gain richer insights into customers' product use, which allow the provider to implement individualized revenue mechanisms like pay-per-use or time-varying fees (Chauhan et al., 2022; Sun et al., 2023). Simultaneously, connectivity can give a manufacturer precise information about an object's status and wear, reducing maintenance costs (Chavez et al., 2023). However, developing/acquiring and implementing digital technologies is often expensive (Belezas & Daniel, 2023), and ensuring that the upsides outweigh the downsides is often not trivial (Bencsik et al., 2023). It is therefore problematic that the value capture dimension has so far received much less attention than the other two dimensions. Value capture as a whole is a ripe area for future research.

Few articles in our sample highlighted how combinatorial innovation affords additional revenues from greater sustainability (Cranmer et al., 2021). However, there are opportunities to generate new revenue streams from sustainability-related apps, such as data commercialization, hosting a marketplace for services of other providers, in-app purchases, or advertisement (Alshawaaf & Lee, 2021; Bencsik et al., 2023). From a strategic management point of view, much more research is needed to explore various value capture mechanisms and compare them across different contexts.

We also propose investigating how firms collaborate with partners, suppliers and customers to capture value collectively. More research is also needed to study how regulatory frameworks shape sustainable value capture strategies (Böttcher et al., 2023). These insights can be particularly important not only for companies, but also for policymakers, offering valuable guidance in adjusting and enhancing legislation.

A holistic view of digital-sustainable business models

In addition to insights on individual business model dimensions, we need a better understanding of digital-sustainable business models as a whole, that is, the integration of specific value propositions, value creation and delivery processes and value capture mechanisms. How can firms best combine distinct manifestations of these elements? What makes distinct manifestations act synergistically versus antagonistically? When should all three dimensions of the DSBM be digitalized and emphasize sustainability, and when should digitalization and sustainability be limited to individual dimensions? Answering such questions will enable strategy scholars to provide practicing managers with academic guidance on how firms can revise their business model to make the most use of digital technologies for sustainability purposes.

In this vein, scholars should also examine the relationship between digitalization and sustainability. Whilst digitalization provides great opportunities for sustainability, tensions and trade-offs also occur. Multiple studies highlight data collection, privacy and rights issues (e.g., Carrera-Rivera et al., 2022; Del Rio et al., 2020; Shepherd et al., 2020; Song, 2019). Ethical issues of AI (Sunar & Swaminathan, 2022) and blockchain (Tan & Salo, 2023) are

also pointed out by some articles, as are implications for human labour (Battisti et al., 2022; Di Vaio et al., 2020; Margherita & Braccini, 2020; Pereira et al., 2018). Further, digital business model innovation can create frictions for customers (e.g., in the case of digital healthcare services; Bärnreuther, 2023; Rey-Garcia et al., 2021). Finally, digital technologies can lead to increased energy consumption (Chin et al., 2022; Liu et al., 2022) and electronic waste (Sun et al., 2023), producing undesired consequences. Generally, the consideration of tensions and trade-offs appears to be underrepresented in the current research on digital-sustainable business models. Paradox theory, which presents the tension between profit maximization and sustainability as a prime example of a paradoxical tension (Smith & Lewis, 2011), could proof useful to such research. Unfortunately, none of the articles in our sample adopted this increasingly popular theory. These observations represent rich opportunities for future work.

Paths for future research with respect to boundary conditions

Although the reviewed literature features initial publications on external (contextual) and internal (organization-specific) boundary conditions for DSBMs, research on both types of boundary conditions is still in its infancy. With respect to external boundaries, only one article in our sample (Alshawaaf & Lee, 2021) analyses the role of regulation and policies. Given the breadth of this topic and its impact on the sustainability transition, we call for further research on how firms design their DSBMs to accommodate legal frameworks, including data protection laws, environmental regulations and industry-specific standards. Conversely, it will also be interesting to see how companies attempt to alter formal and informal institutions in the external environment that impede their ability to commercialize digital and sustainable solutions successfully. Such attempts are studied quite extensively in the general management literature under the name 'institutional entrepreneurship' (Maguire et al., 2004), but have received little attention from the articles in our sample. Beyond legal frameworks, future research could also examine how companies perceive public funding options and how they deal with the requirements or lack of such financing options as government grants.

Consumers' attitudes, norms and routines frequently represent major obstacles to the widespread diffusion of digital and sustainable products and, hence, to the successful implementation of DSBMs (Piscicelli et al., 2018; Shankar et al., 2022). Although many consumers claim to be willing to switch to eco-friendly alternatives in several international surveys (Chen et al., 2019; Ross & Milne, 2021), too few consumers follow through with this intention and many sustainable innovations fail (Palmié et al., 2024; Paparoidamis et al., 2019). A potential explanation for their reluctance to switch is the uncertainty they face about the credibility of 'green' claims (Paparoidamis et al., 2019; Zhang et al., 2021). Since digital technologies can yield greater traceability and transparency, a corresponding design of DSBMs seems to be a promising lever to overcome this challenge. Another research direction can be devoted to investigating digital media, including social networks, and their role in influencing customer attitudes towards DSBMs.

Sustainable solutions commonly emerge from government-industry collaborations (e.g., public-private partnerships) and often require extensive stakeholder engagement to scale (Bencsik et al., 2023). Future research should, therefore, examine how companies can incorporate the demands resulting from their interactions with consumers, regulators and other stakeholders in their DSBMs. Future research can further investigate the interplay between data privacy and security regulations in the development of DSBMs.

With respect to internal boundary conditions of DSBMs, corporate governance—highlighted by Alkaraan et al. (2023) in our sample—represents a promising avenue for future research. Strategic management traditionally focuses on profit-maximizing firms (Nag et al., 2007). Whilst these firms still represent the most commonly studied type of organizations in the reviewed literature, sustainability objectives also invite the proliferation of alternative organizational forms (e.g., cooperatives, not-for-profit enterprises or state-/municipality-owned businesses; Bencsik et al., 2023). Although such organizations are already covered by a few articles in our sample (e.g., Alshawaaf & Lee, 2021; Battisti et al., 2022; Chamakiotis et al., 2021), the influence of the organizational type on DSBMs should be studied systematically. We also need a better understanding of how organizations of different types (such as profit-maximizing firms and municipalities) can coordinate their business models to jointly produce digital and sustainable solutions.

Besides studying organizations with unconventional ownership structures, scholars could also reconsider strategic management's (often implicit) assumptions about owners and managers. Strategic management traditionally focuses on (boundedly) rational managers and owners who seek to maximize their firm's financial performance and/or personal material gain (Boivie et al., 2021; Nag et al., 2007). Growing environmental and social awareness among large parts of society could cause at least some managers and owners to adapt or broaden their objectives. Such changes in their objectives are likely to affect the relationship between managers and owners and

might be reflected in their firm's business model. No article in our sample studied how digital-sustainable business models are affected by principal-agent relationships and what principal-agent mechanisms can support the success of DSBMs. These questions and the reconsideration of the field's behavioural assumptions represent intriguing avenues for future research.

Corporate governance and manager characteristics point to another internal boundary condition that is likely to be crucial for the successful implementation of DSBMs, namely top management support (El-Haddadeh et al., 2021). An intriguing avenue for further research along these lines concerns the distribution of responsibilities for digital sustainability among the members of the top-management team. Traditionally, the responsibility for digital issues was assigned to a different member than the responsibility for sustainability issues. These members may hold divergent ideas about their organization's DSBM, which can cause friction in their support. How can companies respond to such challenges? Future research can also examine how top management decisions contribute to the resilience of organizations in the face of technological disruptions and environmental challenges.

Very few articles in our sample—notably, Chaudhuri et al. (2022), Di Vaio et al. (2021), Lopes de Sousa Jabbour et al. (2023), Paiola et al. (2021) and Palmié et al. (2021)—address questions related to the implementation of digital-sustainable business models directly. We noted above that systematic analyses and strong empirical evidence for synergies, tensions and trade-offs between digitalization and sustainability are rare. These two observations are probably interdependent since a detailed examination of the implementation of DSBMs could have brought synergies, tensions and trade-offs between digitalization and sustainability to the fore. Reinforcing our above call for more research on the interplay between digitalization and sustainability, we encourage scholars to study the implementation of DSBMs to a greater extent. Relatedly, few studies in our sample concerned themselves with ethical issues (Abbate et al., 2023a; Niehoff, 2022). However, ethical considerations are gaining traction in the wider strategy community (Tsoukas, 2018), which indicates their growing relevance. Scholars could ask: Which ethical challenges do companies experience when implementing DSBMs and how do they deal with them?

Finally, the digital affordances highlighted throughout this manuscript indicate that creating, transmitting and recombining knowledge is at the heart of digitalization. An organization's knowledge management strategies and systems can affect how well the organization can implement a particular DSBM and how successful its DSBM is likely to become. Scholars might, therefore, follow the footprints of Di Vaio et al. (2020) and study knowledge management strategies and systems as a boundary condition for DSBMs.

Paths for future research with respect to antecedents

Albeit research on external (contextual) and internal (organization-specific) antecedents is a bit more advanced than research on boundary conditions, it is still in its early growth stage. Whilst no internal antecedent has hitherto been covered twice, some external antecedents have started to appear in multiple studies. Overall, however, both types of antecedents offer ample room for further work.

With respect to external antecedents, a dynamic perspective can prove insightful. Over time, the limited availability of certain natural resources may become more or less severe (e.g., because of substitute materials). Likewise, the status of the digital infrastructure is unlikely to remain constant. Existing digital technologies will mature and new digital solutions will emerge. How do companies adapt their business models in response to these developments? Does the current conceptualization of DSBMs accommodate such adaptations in the best way possible? Public management scholars modified the business model concept to better match public service provision requirements (see Lorenz et al., 2024). Are there any modifications that can optimize the current business model concept for the twin transition?

We further call for more comparative endeavours to illuminate the impact of external antecedents. Most of the empirical studies in our sample have explored relatively few firms and published their findings in specialty journals. Whilst these articles could describe the focal business models in great depth, they paid less attention to questions of generalizability to other settings. How do firms from various industries, locations and regulatory regimes differ in their DSBMs? Such comparative research is needed to disentangle the influence of external antecedents. The embeddedness of DSBMs within specific industries, communities and ecosystems is a complex phenomenon that invites many research methods. For example, stakeholder/ecosystem mapping, network analyses and multi-sided investigations of supply chain interdependencies can illuminate the influence of suppliers and partners on DSBM implementation and success.

Intra-organizational antecedents such as organizational structures and employee/executive characteristics are underrepresented in the reviewed studies. By steering the distribution of work, rewards, task and information flows,

communication networks and more, the internal organization heavily determines what organizational members are willing and likely to do (Chandler, 1962; Helfat & Eisenhardt, 2004; Keupp et al., 2012). Internal organizational arrangements, hence, 'represent some of the most powerful strategic levers available to the top management of the modern corporation' (Gulati et al., 2009, p. 575). Nevertheless, the role of formal and informal organizational structures has received little attention in the reviewed literature. We, therefore, encourage business model scholars to devote more time and effort to the internal organization and how internal structures affect DSBMs. The 'common threefold conceptualization' of organizational arrangements—comprising centralization, formalization and socialization—offers a solid foundation to start such endeavours (Sundaram & Black, 1992, p. 742; also see Ambos & Schlegelmilch, 2007).

It would also be intriguing to study strategies and measures firms could take to complement the implementation of DSBMs. For instance, to secure the reduction of its environmental footprint, a firm implementing a DSBM might complement this business model with a strategy that mitigates rebound effects among its customers. Alternatively, firms wishing to implement a given DSBM might realize that the prevailing rules, norms and beliefs in their societal environment are not well aligned with the requirements of their preferred business model. They could, hence, decide to engage in non-market strategies and institutional work to increase the receptiveness of their environment in favour of the selected alternative (Maguire et al., 2004). Complementarity theory (Brynjolfsson & Milgrom, 2013) could provide scholars with a suitable foundation to study complementary factors.

According to Nag et al. (2007), strategic management is not only about intended initiatives but also emergent ones. Forming the 'microfoundations movement in strategy and organization theory' (Felin et al., 2015), scholars have recently started to pay considerable attention to the question of how firm-level outcomes emerge from the actions and interactions of organizational members (Palmié et al., 2023). Within this movement, the microfoundations of business models tend to remain underexplored (cf. Foss and Saebi (2017); for a notable exception, see Loon et al. (2020)). Future research on the microfoundations of digital-sustainable business models could help close this gap.

Generally speaking, we encourage strategy scholars to leverage larger sample sizes. Studying a greater number of firms can advance our understanding of both external and internal antecedents. It will help us identify general theoretical mechanisms and the impact of external and internal firm characteristics on the development of DSBMs.

Paths for future research with respect to outcomes

As sustainability is inherently concerned with the welfare of a broad set of stakeholders, broadening the focus from organizational outcomes to supra-organizational outcomes of DSBMs is key to realizing the ambition of the sustainability movement. Fortunately, research on both types of outcomes is comparatively well-developed. Additional research is warranted in the following regard. Our literature review indicates that quantitative theory-testing research is underrepresented. Prior work on DSBMs has focused more on exploring individual components of our framework than on studying the relationships and interdependencies among multiple concepts/constructs of interests. Only a few studies explored the interaction between digitalization and sustainability and its effect on firm performance, measuring the latter in economic terms (Chavez et al., 2023; Torrent-Sellens et al., 2023). A focus on economic performance is consistent with the tradition and dominant stance in the strategy field (Nag et al., 2007; Palmié et al., 2023). However, digital-sustainable business models inherently deviate from this trajectory by including social and/or environmental goals in addition to, if not instead of, economic objectives. The synergies and conflicts among economic and non-economic aspirations are still relatively poorly understood and deserve further investigation. More research on this topic is especially warranted since few, if any, activities have implications in just one of these dimensions. Thus, almost everything a firm does inadvertently has economic and non-economic effects. Strategy scholars can, therefore, re-examine many of their findings from an environmental- or social-performance perspective.

More research is also required with respect to the scaling of digital business models that seek to advance social sustainability. Social sustainability is affected by more subjective, qualitative factors than the economic and environmental dimensions; it is difficult to turn these factors into objective and quantifiable indicators (Amrutha & Geetha, 2020; Banerjee, 2011). Social sustainability criteria also tend to be more context-dependent and thus harder to abstract from the specific context than economic and environmental sustainability criteria (Glaser & Diele, 2004). Moreover, social sustainability has not only been argued to be context-dependent but also to be time-dependent—that is to say, it is likely to be a dynamic concept whose meaning can change over time in the same location (Lee & Jung, 2019). These characteristics could impede the successful scaling of social-value business models. Studying social outcomes should be an integral element of the DSBM literature as digitalization and sustainability are both expected

to have implications for individual stakeholders, communities and societies. For instance, the majority of the United Nations' (2015) Sustainable Development Goals (SDGs) emphasize social issues (e.g., no poverty, zero hunger, good health, quality education, gender equality or peace and justice). Similarly, the societal implications of digital technologies are widely and controversially discussed (Fleming, 2019). How do DSBMs affect the quality and quantity of available jobs? Which employee skills will they advance, and which erode? How can negative effects be reduced and positive implications be promoted? Measuring social outcomes will be key to assess whether DSBMs effectively contribute to the SDGs or not.

Another intriguing avenue for future research is the search for business models that are economically attractive without incentivizing firms to produce more and more output. Hitherto, most sustainable business models achieve relative decoupling between resource consumption and economic performance; that is, resource use grows at a slower rate than economic performance (Kjaer et al., 2019; Palmié et al., 2021). Whilst relative decoupling is an environmental improvement over a coupling between resource consumption and economic performance, it still means that pursuing economic gains can lead to more environmental damage. It would, therefore, be desirable to have business models that achieve absolute decoupling—that is, they use fewer resources, the more economic value they generate (Palmié et al., 2021).

THEORETICAL AND PRACTICAL IMPLICATIONS

Our efforts to systematically review and consolidate the literature on digital-sustainable business models from a strategic management perspective make three valuable contributions to academic research and management practice. First, the convergence of digital transformation and the sustainability imperative presents challenges and opportunities for strategic management (Lanzolla et al., 2021; Rabetino et al., 2021). We define digital-sustainable business models and develop a strategic management framework for their analysis. Our definition draws on recent attempts to define related concepts and phenomena, notably smart cities (e.g., Gassmann et al., 2019; Mora et al., 2019) and digital sustainability (George et al., 2021). Our framework integrates three seminal accounts of the characteristics of the strategic management field (Durand et al., 2017; Leiblein et al., 2018; Nag et al., 2007). The proposed definition and framework can guide strategy research at the intersection of digitalization, sustainability and business models—an area which is most likely to be relevant in the foreseeable future. Moreover, our framework can serve as a solid foundation for strategy scholars who want to organize findings in some other domain. Many parts and features of this framework are not specific to digital and sustainable business models. With a few modifications, it should therefore be possible to adapt the framework to other topics and investigate these topics from a strategic management perspective.

Second, we use this framework to synthesize the literature on DSBMs. Originating in different disciplines, prior research on digital-sustainable business models is scattered across various journals, including sustainability and other specialty journals which general and strategic management scholars might not follow closely. Our synthesis of this fragmented research can provide strategy scholars with new insights on how companies can leverage digital technologies to create economic and non-economic value and how companies can address the complexities and potential conflicts that arise from the twin transition. Our literature review hence helps strategy scholars gain a better understanding of how firms can achieve competitive advantage in the era of digital sustainability (Bencsik et al., 2023; George et al., 2021).

Third, we used our strategic management framework to identify research avenues that seem particularly fruitful from a strategic management perspective. The outlined opportunities can allow the strategy community to make much progress fast. The proposed framework and definition could further increase the compatibility of future studies in this area. Such compatibility should benefit the emergence of a joint body of knowledge (Knight et al., 2020; Pfeffer, 1993).

Pursuing the proposed research agenda could not only enhance our theoretical understanding of digital-sustainable business models, but could also improve the academic guidance that strategy scholars can provide to practitioners. From a practical perspective, our review and research agenda highlight several opportunities for managerial agency and intervention. They can generate insights on how executives can navigate benefits and challenges in implementing digital-sustainable business models and how they might adjust their internal structures. Investigating employee resistance and suitable top management support practices could yield a list of 'best practices' for implementing digital-sustainable business models. Integrative treatments of digital and sustainable business models offer new perspectives for creating and capturing value that can stimulate managers' creativity when they engage in business model innovation (Frankenberger et al., 2013). Relatedly, studying ethical issues could inform a 'code of conduct' that ensures the legitimacy of digital-sustainable business models. Legitimacy and consumer approval are paramount to realizing the potential of digital technologies for sustainable development and

thus to achieving sustainable development goals (Sachs et al., 2019). Finally, a better understanding of synergies and conflicts between different sustainability dimensions and goals can give managers a more holistic view of their business performance.

LIMITATIONS OF OUR REVIEW AND ASSOCIATED OPPORTUNITIES FOR FUTURE WORK

Our literature review contains some limitations that entail further opportunities for future work. First, following countless articles in the *International Journal of Management Reviews*, we restrict ourselves to peer-reviewed articles whilst omitting books, book chapters and other non-refereed publications (e.g., Kerr & Coviello, 2019; Rojon et al., 2021; Schaltegger et al., 2022). Literature analyses conducted in this way acknowledge that they are unlikely to cover every single piece of relevant research and, occasionally, even drop some search hits from their analysis to favour the representativeness of their sample over exhaustiveness (e.g., Keupp et al., 2012). Prominent journals and impactful articles tend to shape the theoretical and empirical work in a field by determining the 'horizons for inquiry' (Furrer et al., 2008, p. 2). We tried to capture the most relevant pieces of prior work by not only searching the leading journals dealing with 'digitalization', 'sustainability' and 'business models', but also extending our search to highly cited and hot papers published outside these journals. Nevertheless, we might have missed articles published in lower-ranked outlets that have not caught on yet but will ultimately become impactful in the future.

Second, literature reviews are necessarily a trade-off between depth and breadth. Our intention was to produce a broad account of digital-sustainable business models from an overarching strategic management perspective. It would also be interesting to adopt a narrower focus and delve more deeply into specific topics. For instance, one could study in greater detail how firms incorporate affordances pertaining to one of the three categories (representation, connectivity, recombination) into a selected business model component. Another possibility for greater depth would be to choose a prominent strategic management theory and discuss how the concepts and mechanisms highlighted in this theory affect digital-sustainable business models. Focusing on a single theory allows scholars to include terms related to its central concepts and mechanisms into their search strings and, therefore, identify some articles that a broader approach like ours cannot detect.

Third, we searched for articles at the intersection of digitalization, sustainability and business models. There are alternative approaches to address the topic of digital-sustainable business models. Scholars could alternatively tackle the two-way intersection between digitalization and business models, the two-way intersection between sustainability and business models, and contrast their findings from both streams to arrive at an account of digital-sustainable business models. Another alternative involves analysing the literature at the two-way intersection of digitalization and sustainability and subsequently applying these findings to our knowledge about business models. We believe the three-way intersection represents a powerful starting point to synthesize existing research on digital-sustainable business models. However, we believe the three approaches are complementary and encourage scholars to pursue the other alternatives.

CONCLUSION

Business models have become one of the most prominent topics in the strategy field and have pervaded other domains of management research as well. Consequently, considerable efforts have been undertaken to study business models in the context of megatrends like digitalization and sustainability, leading to literature streams on digital business models and sustainable business models. Both literature streams have begun to account for 'the other' megatrend so that their research interests increasingly overlap. Similarly, strategic and general management scholars have recently become interested in the intersection of digitalization and sustainability, immediately calling for empirical research on business models for 'digital sustainability' (George & Schillebeeckx, 2022; George et al., 2021; Höllerer et al., 2022). To provide a solid foundation for this future strategy research, our article proposes a definition of digital-sustainable business models, develops an integrative strategic management framework from seminal accounts of the strategy field, synthesizes the fragmented prior investigations at the intersection of digitalization, sustainability and business models in a systematic literature review, and identifies promising avenues for future research by applying the framework to the findings from the literature synthesis. We hope our efforts support strategy scholars in advancing our understanding of business models for digital sustainability as much as possible.

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