


# Digital ecosystems and their impact on organizations—A dynamic capabilities approach

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## Abstract

Digital ecosystems (DEs), driven by information and communication technologies, are reshaping the way firms create, deliver, and capture value across interconnected networks. These dynamic and loosely coupled ecosystems facilitate collaboration and innovation among firms, customers, suppliers, and partners. While research on digital transformation (DT) has often focused on internal firm changes, the influence of DEs on the set of capabilities at the ecosystem, partner, and focal firm levels remains underexplored. This paper addresses this gap by adopting a dynamic capabilities (DCs) framework to investigate which capabilities are required by a firm engaging in DEs. Through a systematic literature review, we identify 17 DCs essential for firms to adapt to ecosystem-based interactions. Our findings reveal that success in DEs requires firms to co-create and co-deliver value through new capabilities that leverage data, foster cooperation, and align operations with the broader ecosystem. We propose a multi-level framework that highlights the critical role of interfirm collaboration and offers actionable insights for firms navigating increasingly interconnected digital environments. Lastly, we present five future research directions that address gaps at different levels of ecosystem research.

## INTRODUCTION

Digital ecosystems (DEs) have emerged as a significant force in business, driven by the rise of information and communication technologies (ICTs) that are transforming the way companies interact with customers, suppliers, and competitors (Miloš & Gavrilović, 2021). Examples of such DEs exist in a variety of different sectors, such as healthcare (e.g. Edison offered by General Electric), finance (e.g. Plaid), service (e.g. Apple), or manufacturing (e.g. EcoStruxure offered by Schneider Electric). DEs are dynamic, loosely coupled networks of organizations

that collaborate across digital platforms, fostering innovation, enhancing agility, and creating new forms of value (Riasanow et al., 2021). Defined by Jacobides et al. (2019, p. 14) as ‘interacting organizations that are digitally connected and enabled by modularity, and are not managed by a hierarchical authority’, DEs are understood in this study as networks of organizations interacting at three levels: (1) the ecosystem level, (2) the partner level, and (3) the focal firm level. These ecosystems are reshaping industries—ranging from manufacturing to services—by enabling firms to transcend traditional boundaries and form interconnected business networks that collectively

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create, deliver, and capture value (Kamariotou & Kitsios, 2022; Kohtamäki, Rabetino, et al., 2022).

Although the role of digital transformation (DT) in shaping individual firms' business models (BMs) has received significant attention, there is a notable gap in understanding how BMs evolve within the broader context of DEs. Current literature primarily focuses on the internal impacts of DT (Cavusgil & Deligonul, 2024; Töytäri et al., 2018), such as improving processes and customer relationships (Palmié et al., 2022). What remains underexplored is how firms integrate into and co-evolve with DEs (Rachinger et al., 2019), where their success increasingly depends on interfirm collaboration, shared value creation, and mutual dependencies that stretch across multiple layers of interaction (Riasanow et al., 2021). This represents a critical research gap, as firms are no longer isolated actors but part of larger, dynamic systems of value creation. The ways in which DEs influence BMs, and how these models must adapt to the complexities of ecosystem-based interactions, remain poorly understood. As company boundaries are becoming increasingly blurred, a new conceptual understanding of dynamic capabilities (DC) in the context of DEs is needed, especially in cases where interdependencies in the BM of one company may not be actively reflected in the BMs of other companies within the same ecosystem (Adner, 2017; Hanelt et al., 2021; Jacobides et al., 2018, 2019; Kohtamäki et al., 2019; Langley et al., 2021). This need is reflected in the proposed research avenues of many scholars who call for research at the intersection of DT and BMs through an ecosystem perspective (Kohtamäki et al., 2019; Palmié et al., 2022; Parida et al., 2019; Teece, 2018). Addressing this gap, this paper investigates what DCs at the ecosystem, partner, and focal firm levels are required by companies engaging in DEs. The core research question (RQ) is as follows: *Which dynamic capabilities are required by firms engaging in digital transformation-enabled ecosystems at the ecosystem, partner, and focal firm levels?*

To address this question, the paper conducts a systematic literature review (SLR) that synthesises existing research on the intersection of DEs and BMs while identifying the DCs necessary for firms to succeed within these ecosystems—sensing, seizing, and reconfiguring—enable firms to adapt to rapidly changing environments (Teece, 2007), particularly within DEs where collaboration and digital connectivity define the landscape (Adner, 2017; Hanelt et al., 2021; Jacobides et al., 2018). These capabilities help firms navigate the challenges of ecosystem orchestration, align with partners, and continuously reconfigure their operations in response to evolving ecosystem dynamics (Teece, 2018).

The findings of this study contribute to closing the identified research gap by offering a multi-level perspective on

how DEs reshape BMs. The paper identifies 17 DCs that firms must develop to adapt their BMs within DEs, emphasising the importance of aligning these capabilities at the ecosystem, partner, and focal firm levels. This multi-level approach offers a more comprehensive understanding of how DT alters the structures and dynamics of BMs, extending the current literature and providing actionable insights for firms operating in increasingly interconnected digital environments (Kohtamäki et al., 2019; Vaska et al., 2021).

## RESEARCH DESIGN

For our study, we chose the SLR methodology as a suitable tool to review the existing literature and to synthesise findings in cross-discipline areas (Bhimani et al., 2019). The SLR process consists of five steps, depicted in Figure 1, and provides rigorous, objective, and transparent results (Denyer & Tranfield, 2009; Kolagar, Parida, et al., 2022). SLRs play a crucial role in assessing current research and putting forward new research directions (Breslin et al., 2020). Synthesis is a key component of an SLR applied in management research, as it critically draws evidence from different research streams to assess an RQ and provide insights from the literature (Rojon et al., 2021). This review synthesises 56 articles published or available at the time of the search in September 2022. It follows methodological best practices for conducting an SLR to draw conclusions based on existing literature by including both conceptual and empirical papers; including both types of papers creates a significant body of literature for an inclusive and thorough review process (Redgrave et al., 2023).

In the planning phase, we conducted several interviews with industry experts in the domain of DT-driven ecosystems, such as platform providers and data hubs, to identify relevant gaps in the scope of changes in BMs in DEs. During this phase, we conducted six semi-structured interviews with managers and experts from five companies, as depicted in Table 1. The identified research gaps were discussed between the authors in several rounds to construct the RQ and formulate search strings. In the third phase, we used the Scopus database as a source for high-quality peer-reviewed journals, as these have the highest impact in the field, to ensure the quality and reliability of the research (de Oliveira et al., 2018; Hanelt et al., 2021; Khan et al., 2023; Kohtamäki, Whittington, et al., 2022; Suryono et al., 2019). The search string included the terms digital transformation, digitalisation, digitisation, Industry 4.0, digital technology, or digital technologies, along with the term ecosystem, to provide insights into the intersection of DEs. The initial search string provided 2908 results, which were then filtered in the third step,

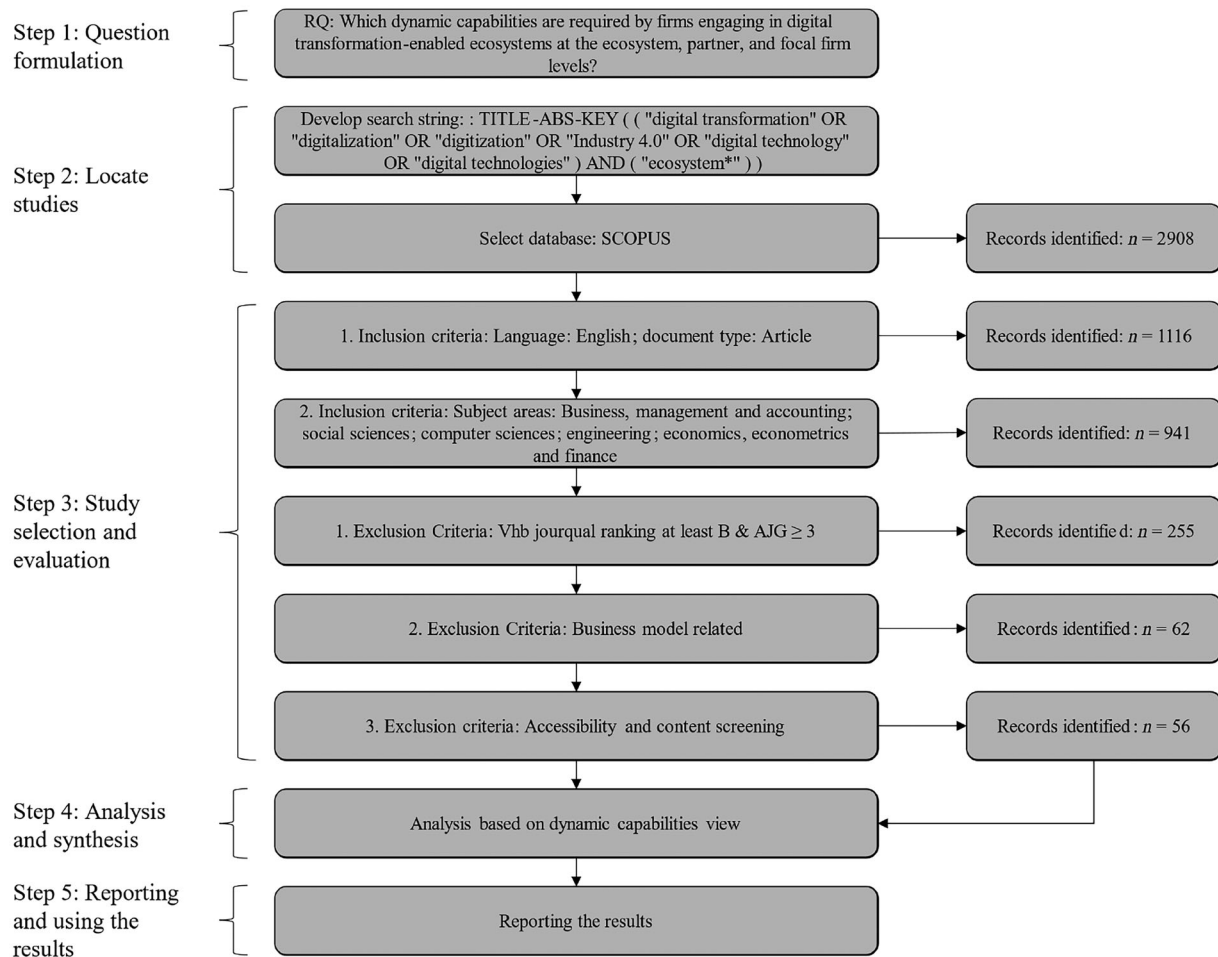


FIGURE 1 Systematic literature review process based on Denyer and Tranfield (2009).

TABLE 1 Preliminary interviews.

No.	Job title	Company description	Duration
Interview 1	Chief executive officer	The company provides a digital production platform that serves as a key infrastructure component in connecting various actors via a data hub	47 min
Interview 2	Business development manager	The company is a premium service and license reseller focusing on enterprise customers.	58 min
Interview 3	Ecosystem manager	Multinational technology corporation which has built an industry-leading connectivity ecosystem.	62 min
Interview 4	Partner development manager	The company provides a marketplace solution for digitisation and data conversion software for various industries.	74 min
Interview 5	Senior data consultant	The company offers consulting services for various industries fostering and enabling data connectivity, data sharing, and data analysis for their clients.	41 min
Interview 6	Senior management advisor	This company consults firms in their digitisation journey from planning to implementation of complex IT systems and services.	38 min

study selection and evaluation; the different exclusion and inclusion criteria used are provided in Figure 1.

First, the search results were filtered to include only articles, and due to resource constraints, only articles written in English were considered. We limited the articles to the following subject areas—business, management and

accounting, social sciences, computer sciences, engineering, economics, econometrics, and finance—to ensure that key business, management, and adjacent fields would be reviewed (Mountford & Cai, 2022). Due to the large number of papers identified and our goal to select studies with strong theoretical and methodological rigour, we only

considered articles published in leading journals. Two academic rankings were used for this purpose: (1) the VHB-Jourqual ranking, in which only journals with a ranking of at least B were considered (Hohenstein et al., 2015; Kraus et al., 2020), and (2) the Academic Journal Guide, in which the focus was on publication levels 4\*, 4, and 3 (Blevins et al., 2022; Boccoli et al., 2023; Glasbeek et al., 2024).

To ensure that the selected articles focused on the scope of our literature review and followed prior research practices, the titles, keywords, and abstracts of the 255 remaining articles were screened for their relevance to the topic of BMs as defined in the previous section (Klarner et al., 2023). After the initial screening, 62 high-quality peer-reviewed papers were considered as the body of analysis, of which six were not retrievable. This led to a set of 56 papers that were analysed in the fourth step. An overview and summary of the papers categorised by the applied ecosystem definition can be seen in [Supporting Information Appendix A](#). The results are reported in the following section.

## CONCLUDING RESULTS

In this section, we review the literature regarding the necessary DCs and their influence on the three dimensions of BMs in DEs: value creation, value delivery, and value capture. As illustrated in Table 2, we distil 17 DCs at three different analytical levels: the level of the ecosystem, the partner firm level, and the focal firm level.

### Sense

At the ecosystem level, the capabilities to develop and maintain *digital infrastructure* are vital for building the necessary technological foundation for information exchange among ecosystem participants. This infrastructure supports the seamless flow of data, enabling firms to sense opportunities for innovation and collaboration (Balodi et al., 2022; Cennamo et al., 2020; Immonen et al., 2016; Subramaniam, 2020; Volberda et al., 2021). For instance, digital platforms as key infrastructure components aid in obtaining knowledge and data in new business entity relationships (Nambisan, Zahra, et al., 2019; Schiavone et al., 2021; Taylor et al., 2019). *Transparent value proposition formulation* at the ecosystem level ensures that all participants are aware of the potential benefits and contributions of each member, thereby fostering a cohesive and collaborative environment, which is pivotal for identifying means to co-create, capture, and deliver value (Burström et al., 2021; Leone et al., 2021; Ruokolainen et al., 2023). Especially when entering ecosystems, value

propositions and data collection must be transparent and recognisable by partners and competitors alike to build a mutual basis for value creation (Jingyao et al., 2021; Langley et al., 2021; Ruokolainen et al., 2023).

For partner firms, *transparent value proposition formulation* builds an essential sensing capability, as this capability involves clearly defining and communicating the value that each actor brings to the DE, ensuring alignment with potential partners to foster trust and collaboration. Transparent value propositions facilitate the identification of synergies and build the foundation for establishing mutually beneficial relationships (Kolagar, Reim, et al., 2022; Ruokolainen et al., 2023).

At a focal firm level, firms must have the capability to sense opportunities within the DE that heavily rely on *partnership, market, and technology scanning*. With the increasing pressure to leverage both internal and external resources (Kolagar, Parida, et al., 2022; Wagner, 2021), our findings indicate that partnership scanning plays a crucial role in shifting from resources that are solely possessed by a single company towards collaboration within an ecosystem in which the identification of partners plays a central role in collaboratively forging new means of value creation and delivery. This shift becomes apparent in publications such as Sjödin et al. (2021) that emphasise the importance of combining data from multiple internal and external sources, such as sensor data and access to private databases such as the enterprise resource planning or customer relationship management systems, to create more sophisticated artificial intelligence (AI)-based solutions. The increasing number of opportunities introduced through the ecosystem leads to new capabilities where partnerships, markets, and emerging technologies must constantly be assessed to '*mutually grant[ed] access to complementary assets and resources in order to boost their digital service levels or reduce costs*' (Kolagar, Parida, et al., 2022, p. 186). Partnership scanning aids firms in identifying potential collaborators who can provide complementary resources, data, and capabilities. Market and technology scanning are crucial for maintaining competitive advantages and mitigating the risks of lacking technological capabilities by offsetting know-how gaps through extensive collaboration within the DE. Firms must continually assess market trends and technological advancements to identify opportunities for innovation and value creation (Kolagar, Parida, et al., 2022; Sjödin et al., 2022). Jointly co-creating value in a DE (Andrade & Gonçalo, 2021) by offering adaptive (Kopalle et al., 2019; Subramaniam, 2020; Taylor et al., 2019) or customised products (Sehnm et al., 2022) unveils new routines for identifying complementors (Subramaniam, 2020), partnerships (Kolagar, Reim, et al., 2022; Sjödin et al., 2022), and opportunities for value co-creation (Kopalle et al., 2019; Linde et al., 2021). These new

TABLE 2 Dynamic capabilities in digital ecosystems.

Phase	Dynamic capability	Description	Key concepts	Operationalization
<i>Ecosystem level: Sense</i>				
	Digital infrastructure	The capability to develop and maintain technological foundations enabling information exchange and seamless data flow among ecosystem participants, supporting innovation and collaboration opportunities	For example emphasis on digital platforms and marketplaces (see Balodi et al. [2022] and Cennamo et al. [2020]), the enablement and interoperability of technical infrastructures (see Immonen et al. [2016] and Volberda et al. [2021]), and increased access and sharing of product, user, and usage data (see Subramaniam [2020])	Implementation of digital platforms and protocols that enable systematic knowledge exchange and data sharing across organizational boundaries, supported by an infrastructure for real-time information flow
	Transparent value proposition formulation	The capability to ensure all participants understand the potential benefits and contributions of each member, fostering a cohesive environment for value co-creation	For example implementation of routines for joint value creation mechanisms (see Burström et al. [2021] and Jingyao et al. [2021]), operational practices for flexible transmission of data (see Leone et al. [2021]), and emphasis on routinised and formalised mutual relations and interactions within ecosystems (see Ruoklainen et al. [2023])	Development of clear documentation and communication frameworks that articulate value creation mechanisms and participant contributions, ensuring transparency in benefit sharing across the ecosystem
<i>Ecosystem level: Seize</i>				
	Connectivity	The capability to establish and maintain data pipelines and sharing modes crucial for enabling collaborative innovation and value creation	For example emphasis on the importance of continuous connectivity across the value chain for value creation (see Subramaniam [2020] and Burström et al. [2021]) or the continuous integration of data-sharing mechanisms for developers, users, and platform providers (see Katsamakos & Pavlov [2022] and Balodi et al. [2022])	Establishment of secure data pipelines and sharing mechanisms that facilitate both real-time and historical data analysis, enabling collaborative innovation across ecosystem participants
	Ecosystem structuration	The capability to establish and maintain governance mechanisms and structural elements that facilitate collaboration	For example definition of rules for cross-functional collaborative development and organizational transformation for establishing ecosystem collaboration (see Sjödin et al. [2021] and Wang & Bai [2021]) or the definition of recurring predefined interactions and formalisation of collaboration routines (see Kolagar, Reim, et al. [2022])	Creation of formal governance frameworks that define roles, responsibilities, and collaborative processes, supported by mechanisms that foster a shared mindset across ecosystem participants

(Continues)

TABLE 2 (Continued)

Phase	Dynamic capability	Description	Key concepts	Operationalization
<i>Ecosystem level: Transform</i>				
	Ecosystem identity formation	The capability to establish shared identity and common goals among participants, fostering collaboration and sustainability	For example fostering collaboration through physical proximity and constant realignment of ecosystem goals in consideration of participants' goals (see Bouncken & Kraus [2022] and Kolagar, Parida, et al. [2022]) or the creation of exclusivity through strong leadership within the ecosystem (see Khanagha et al. [2022])	Development of shared vision and goals while establishing mechanisms for knowledge exchange that balance individual interests with collective ecosystem objectives
<i>Partner level: Sense</i>				
	Transparent value proposition formulation	The capability to clearly define and communicate value contributions, ensuring alignment with potential partners	For example development of routines to explicate ecosystem value propositions (see Kolagar, Reim, et al. [2022] and Ruokkolainen et al. [2023])	Implementation of clear metrics and communication channels that demonstrate value contributions while building trust through transparent alignment processes
<i>Partner level: Seize</i>				
	Coopetition capabilities	The capability to manage simultaneous competition and collaboration, building on promised value propositions	For example formalising agreements in which knowledge, processes, or data are exchanged with competitors (see Kamalaldin et al. [2021]) or the creation of predefined interactions for successful coopetition (see Kolagar, Reim, et al. [2022])	Establishment of governance frameworks and resolution processes that enable effective management of competitive and collaborative relationships within the ecosystem
	Collaborative business model development	The capability to co-create value and establish processes leveraging multiple firms' strengths	For example combination of several data sources for a collaborative value proposition (see Butollo et al. [2022] and Kolagar, Reim, et al. [2022]) or the creation of novel ecosystem-wide value propositions (see Chen et al. [2021])	Creation of joint value-creation processes and resource-sharing mechanisms that leverage complementary strengths through structured collaborative frameworks
<i>Partner level: Transform</i>				
	Ecosystem knowledge synergy	The capability to leverage collective ecosystem knowledge for novel value propositions	For example analysis of ecosystem-wide data facilitated through semi-autonomous or fully autonomous solutions (see Burström et al. [2021]), the implementation of responsive and perceptive mechanisms for knowledge exchange (see Leone et al. [2021]), or establishing cultures of transparency and openness within the ecosystem (see Kolagar, Reim, et al. [2022])	Implementation of knowledge-sharing platforms and joint development processes that facilitate collective learning and innovation across ecosystem partners

(Continues)

TABLE 2 (Continued)

Phase	Dynamic capability	Description	Key concepts	Operationalization
	Business model innovation capabilities	The capability to implement continuous innovation processes and foster a culture of constant change	For example creation of an agile business model innovation environment (see Lindgren et al. [2021] and Valter et al. [2020]) or the shift to dynamic business models enacted through continuous resource integration practices of ecosystem actors (see Langley et al. [2021])	Development of systematic assessment routines and monitoring processes that enable continuous business model evolution and adaptation
<i>Focal firm level: Sense</i>				
	Partnership scanning	The capability to identify and evaluate potential ecosystem partners and collaboration opportunities	For example reconfiguration of existing relations through ecosystem partnerships (see Kolagar, Parida, et al. [2022] and Wagner [2021]) or using ecosystems as catalysts for value enablement partnerships (see Sjödin et al. [2021])	Implementation of structured evaluation frameworks that assess potential partners based on resource complementarity and strategic alignment
	Market and technology scanning	The capability to assess market trends and technological advancements for innovation opportunities	For example the impact of fast-paced market changes motivating ecosystem transformation (see Kolagar, Parida, et al. [2022] and Sjödin et al. [2022])	Development of systematic processes for analysing market trends and technological developments to identify strategic innovation opportunities
<i>Focal firm level: Seize</i>				
	Coopetition capabilities	The capability to manage relationships with competitors who are also partners	For example integration and coordination of value activities through actor competencies and knowledge transformation with suppliers and competitors (see Kolagar, Parida, et al. [2022] and Makkonen et al. [2022])	Creation of protocols and frameworks that manage competitive tensions while fostering collaborative value creation through clear governance systems
	Collaborative business model development	The capability to join forces with partner firms by closely aligning value propositions and developing digital business strategies, enabling swift organizational transformation and new means of value co-creation	For example alignment of value proposition for a shift from granular function to integrated processes focusing on business value (see Makkonen et al. [2022] and Sklyar et al. [2019]) or fostering digital capabilities for the instant creation of new digital business models (see Hanelt et al. [2021] and Linde et al. [2021])	Development of integrated digital business strategies that align value propositions across partners while enabling the addition of digital services into existing solutions
	Partnership mapping	The capability to identify gaps and assess requirements from potential partners	For example establishing self-reinforcing mechanisms to enhance trust between ecosystem actors (see Kolagar, Parida, et al. [2022] and Sun et al. [2021]) or the closing of digital capabilities gaps through the emergence of a meta-ecosystem (see Palmié et al. [2022])	Development of analytical frameworks that systematically assess capability gaps and partner requirements to optimise ecosystem collaboration

(Continues)

TABLE 2 (Continued)

Phase	Dynamic capability	Description	Key concepts	Operationalization
<i>Focal firm level: Transform</i>				
	Openness and flexibility	The capability to adapt to changes and incorporate new technologies and practices	For example fostering different collaboration approaches within the ecosystem (see Brock et al. [2019]) or the opportunity to quickly adapt value creation and value delivery mechanisms facilitating digital platforms (see Nambisan, Zahra, et al. [2019])	Implementation of adaptive protocols and integration frameworks that enable rapid response to technological changes and ecosystem evolution
	Business model innovation capabilities	The capability to continuously evolve business models aligned with ecosystem dynamics	For example integration of innovation activities that leverage in-house and distributed knowledge, skills, and resources from partners, competitors, and customers (see Brock et al. [2019], Leão & da Silva [2021], and Kolagar, Parida, et al. [2022])	Establishment of reconfiguration processes and transformation protocols that enable continuous business model evolution in response to ecosystem dynamics

routines focus on the implementation of processes to scan the market for relevant technologies and partners, as well as the evaluation of new potential avenues in the context of respective BMs (Linde et al., 2021), as ‘*embracing new technologies is necessary but not sufficient on its own [...] Organizations [...] require strong routines to compete in the digital era [...] for creating and capturing value*’ (Volberda et al., 2021, pp. 6–7).

## Seize

Building on the established digital infrastructure, *connectivity* emerges as an important capability at the ecosystem level. Data pipelines and modes of data sharing are critical for enabling collaborative innovation and value creation. With new means of connectivity (Balodi et al., 2022; Subramaniam, 2020), data are increasingly becoming a crucial resource for creating new value by generating insights through historical and real-time data (Burstrom et al., 2021), as well as product and user data (Katsamakas & Pavlov, 2022; Subramaniam, 2020), and sharing valuable datasets within an ecosystem (Schivone et al., 2021) via closed data pipelines (Sjodin et al., 2021). From the generated information, novel products and services can be created such as e-commerce platforms that provide added value by combining data from the participating entities to offer innovative personalisation possibilities (Song et al., 2022) or the creation of predictive algorithms through exploiting the knowledge within an ecosystem via ana-

lytical intelligence to unveil new opportunities for value creation based on the generated data (Leone et al., 2021).

*Ecosystem structuration* capabilities are necessary to establish and maintain the structural elements of an ecosystem, such as the governance mechanisms, that facilitate collaboration and ensure the smooth operation of the ecosystem (Sjodin et al., 2021; Wang & Bai, 2021). Some structural mechanisms for effective participation in DEs are based on recurring and predefined interactions that facilitate collaboration and strengthen ecosystem bonds by defining the clear responsibilities and roles of ecosystem actors (Kolagar, Reim, et al., 2022). Formal agreements can aid in formalising implicit governance mechanisms to deliver and capture value with partners and competitors alike (Jingyao et al., 2021). These new structural mechanisms introduce challenges to the existing cultures of firms now participating in DEs (Kolagar, Parida, et al., 2022), as the necessary collaborative mindset must be established and supported by a whole organization (Makkonen et al., 2022) to provide the required openness for successful value creation, delivery, and capture with multiple actors (Jingyao et al., 2021; Sjodin et al., 2021). In contrast to rigid formalised structure mechanisms, some studies emphasise loose hierarchical structures (Volberda et al., 2021) that build the basis for a shared identity in the ecosystem that can be further facilitated through shared trademarks (Khanagha et al., 2022) or through establishing common goals, routines, or visions (Bouncken & Kraus, 2022). A mutual sense of identity can help in the exchange of tacit knowledge (Bouncken & Kraus, 2022) as well as support

finding a balance between the self-interests of actors and the proclaimed purpose of the ecosystem (Kolagar, Parida, et al., 2022).

At the partner firm level, firms must posit *coopetition capabilities* to be able to build on the promised value propositions (Kamalaldin et al., 2021). Building collaborative BMs involves co-creating value and establishing processes that leverage the strengths and resources of multiple firms within an ecosystem (Butollo et al., 2022; Chen et al., 2021). Effective collaboration and joint innovation are essential for capturing value in DEs (Kolagar, Reim, et al., 2022). Clear governance structures are not only relevant for ecosystem structuration and orchestration but also crucial in times when many scholars propose increasingly blurry firm boundaries, where the distinction between a firm and its external environment diminishes (Hanelt et al., 2021; Langley et al., 2021; Wang & Bai, 2021), as the body of literature emphasises the importance of clear boundaries and structure mechanisms to address the challenges induced by interconnected BMs (Lindgren, 2020). Interconnected BMs can result in conflicting relationships among competitors and ecosystem partners (Jingyao et al., 2021) in a coopetition scenario (Kamalaldin et al., 2021; Kolagar, Reim, et al., 2022). At the partner firm level, firms must posit the *capability to identify and benefit from new BM paradigms* (Brock et al., 2019) by adapting their BMs accordingly, for instance, towards open platforms (Weking et al., 2019), or even by rebuilding core components of their BMs according to the digital vision and culture within the DE (Leão & da Silva, 2021).

Relatedly, focal firms must develop *collaborative BM development capabilities* to join forces with partner firms by closely aligning value proposition (Makkonen et al., 2022; Sklyar et al., 2019) with different partners; this can include adding digital services into the offered solutions (Linde et al., 2021) or developing a digital business strategy to ‘*unfreeze the organization for swift transformation*’ at the firm level (Hanelt et al., 2021, p. 11). Although the identification of partnerships and technologies plays a crucial role in unveiling new means of value co-creation in a DE, value delivery in an ecosystem hinges on the capability to navigate a variety of novel means of value co-creation through *mapping partnerships* (Kolagar, Parida, et al., 2022). Mapping partnerships aids the focal firm in identifying gaps in their capabilities and assessing the requirements they seek from potential partners (Kolagar, Parida, et al., 2022; Palmié et al., 2022; Sun et al., 2018). Assessment and evaluation require distinct processes to reorganise a DT-driven ecosystem by engaging with new digital partners to collaboratively create new BMs to bring developed solutions and partnerships to fruition (Sjödin et al., 2022). Our results further indicate a need for focal firms to establish *coopetition capabilities* to aid in loosening tension induced

through simultaneous collaboration and competition by establishing a foundational collaborative mindset at the focal firm and integrating it into the whole organisation (Kolagar, Parida, et al., 2022; Makkonen et al., 2022). Such routines and capabilities establish the required openness to make sense of the identified partnerships and avenues for offering new value propositions enabled through data, technology, and knowledge sharing within an ecosystem (Jingyao et al., 2021; Nambisan, Zahra, et al., 2019; Sjödin et al., 2021).

## Transform

At the ecosystem level, *ecosystem identity formation capabilities* are crucial for effectively co-creating, capturing, and delivering value in DEs. While collaborating with competitors, partners, and customers provides many benefits, several studies emphasise the need for various means of ecosystem structure and processes that can facilitate establishing a shared ecosystem identity (Bouncken & Kraus, 2022; Khanagha et al., 2022). Ecosystem identity formation involves the establishment of a shared identity and common goals among ecosystem participants, fostering a sense of belonging and nurturing a collaborative environment. As the body of literature indicates, engaging in or initiating a DE impacts value creation by establishing new means of value co-creation either through horizontal collaboration with suppliers, technology providers, and customers (Leone et al., 2021) or by establishing an open innovation framework for a joint value-creation approach, as the findings of Brock et al. (2019) highlight. These capabilities are essential for the long-term success and sustainability of BMs that hinge on DEs (Bouncken & Kraus, 2022; Kolagar, Parida, et al., 2022). A mutual sense of identity can help exchange tacit knowledge (Bouncken & Kraus, 2022) and support finding a balance between actor self-interests and the proclaimed purpose of the ecosystem (Kolagar, Parida, et al., 2022). Establishing the mindset of a mutual identity can be a challenge for firms in which previously firm-centric logics and cultures are now faced with a shared ecosystem vision (Kolagar, Parida, et al., 2022); however, establishing and supporting a collaborative mindset is necessary to foster the culture of openness required to successfully create, deliver, and capture value with multiple actors (Makkonen et al., 2022). Some mechanisms to establish this joint identity can take the form of recurring and predefined interactions that facilitate collaboration and strengthen the ecosystem bonds by defining and formalising the clear responsibilities and roles of the ecosystem actors (Jingyao et al., 2021; Kolagar, Reim, et al., 2022).

Our results indicate that partner firms require two transform capabilities, *ecosystem knowledge synergy* and *BM*

*innovation capabilities*, to effectively transform BMs within DEs. Ecosystem knowledge synergy leverages the collective knowledge and expertise of the ecosystem to find novel value propositions. Co-creation capabilities and BM innovation capabilities are essential for developing and implementing new BMs and value propositions that align with an ecosystem's goals and dynamics (Kolagar, Reim, et al., 2022). Jointly delivering value based on digital solutions in a DE forces partner firms to assess the resources that enable the company to differentiate itself in the market by developing and deploying its unique resources and ensuring alignment with customers and ecosystem partners (Burström et al., 2021; Leone et al., 2021). This collaborative approach requires firms to share knowledge and data within their ecosystem at different points in the customer journey to provide individualised solutions (Schiavone et al., 2021). Kolagar, Parida, et al. (2022) have described this process of capitalising on joint knowledge development and collaboration by gathering market data as ecosystem knowledge synergy.

*BM innovation capabilities* build on the identified avenues for novel value co-creation, capture, and delivery by implementing continuous BM innovation processes that establish and foster a culture of constant change as well as the strategic assessment of existing BMs (Lindgren et al., 2021; Valter et al., 2020). As Langley et al. (2021) emphasise, BMs in DEs are not static, and BM innovation capabilities therefore require routines and processes for constantly assessing the ecosystem (Kolagar, Parida, et al., 2022). These routines and processes include, for instance, implementing monitoring and control processes (Burström et al., 2021) to ensure value capture can occur at different levels of the value chain (Rocha et al., 2021; Wang & Bai, 2021). Such assessment criteria can range from measuring the ecosystem's health, resilience, and sustainability (Kolagar, Parida, et al., 2022; Sehnem et al., 2022) to the evaluation of resource flow in the ecosystem (Langley et al., 2021).

Successfully implementing BMs that build on DEs requires focal firms to have *openness and flexibility* and *BM innovation capabilities*. Openness and flexibility enable firms to adapt to changes and incorporate new technologies and practices (El Sawy et al., 2010; Nambisan, Zahra, et al., 2019). Incorporating the necessary openness and flexibility to share knowledge, know-how, data, and resources is required to create and deliver value that no ecosystem actor would be able to offer independently (Brock et al., 2019). Especially for capturing value, close value stream alignment is required (Hiteva & Foxon, 2021). The need arises for distinct processes for value creation and capture for the core ecosystem actors, such as the quadruple helix actor approach proposed by Brock et al. (2019), to balance the profit of all ecosystem actors by providing clear incen-

tives for third parties to partake in the ecosystem, such as access to data (Sjödin et al., 2022). With this shift of relationships emerging as a strategic resource (Palmié et al., 2022), external knowledge can be integrated into internal innovation activities and contribute to value capture (Brock et al., 2019).

BM innovation capabilities allow focal firms to continuously evolve their BMs to align with the dynamic ecosystem environment (Brock et al., 2019; Leão & da Silva, 2021); however, this capability requires processes and routines to successfully transform an organization. This capability requires routines to reconfigure the BMs of focal firms, in which, based on the scanned and mapped external environment, fruitful opportunities to engage in partnerships to facilitate access to new technologies and digital processes arise (Kolagar, Parida, et al., 2022; Leão & da Silva, 2021). The implementation of co-creation routines revolves around lasting and effective collaboration to build the necessary trust to catalyse value co-creation, co-capture, and co-delivery in the innovated BM (Andrade & Gonçalo, 2021; Kolagar, Reim, et al., 2022). This leads to the emergence of capabilities to identify new BM paradigms (Brock et al., 2019) and integrate continuous BM innovation processes (Lindgren et al., 2021; Valter et al., 2020) that adapt BMs towards open platforms (Weking et al., 2019) or even rebuilding core components (Leão & da Silva, 2021).

## DISCUSSION

Our SLR has approached the effects and implications of BMs that are built on DEs to draw conclusions based on the current state of the literature using a DC lens. To provide a nuanced understanding, the results are discussed here on three analytical levels: the ecosystem level, the partner firm level, and the focal firm level.

### Ecosystem level

At the ecosystem level, collaboration and openness are essential for facilitating innovation, value creation, and relationships with partners, suppliers, customers, and competitors. Collaboration and openness are increasingly important resources to foster synergies, share knowledge, and co-create value (Sjödin et al., 2022). This shift comes not without challenges at the ecosystem level where previously firm-centric logics for value capture and delivery can lead to conflicting profit formulas between ecosystem actors and traditional value chain-focused processes that are inefficient for the flexible nature of collaboration and multidimensional revenue streams (Brock et al., 2019; Sjödin et al., 2022). As Cusumano et al. (2019) emphasise, an ecosystem emerges around a joint value proposition and

managers must adjust their ecosystem strategy and BM accordingly. Thus, we propose approaching DEs by establishing an ecosystem meta-identity that defines a set of behavioural expectations that lead to a shared identification process within the ecosystem, providing legitimation and aiding coordination of the actors. Although a strong identification with an ecosystem's vision poses many benefits, it also increases interdependencies (Palmié et al., 2022; Subramaniam, 2020) and shifts the power between the relevant actors (Parker et al., 2016; Song et al., 2022). Mitigating these aspects requires strong and adaptable governance mechanisms to aid complementary innovation (Jingyao et al., 2021) and create stability for lasting collaborations over time (Kolagar, Reim, et al., 2022).

### Partner firm level

At the partner firm level, firms must be able to effectively navigate the vast amount of collaboration opportunities and arising interdependencies within an ecosystem to create, deliver, and capture value (Leão & da Silva, 2021; Wagner, 2021). Partner firms must align their strategies, objectives, and resources within the ecosystem to achieve mutual benefits and create a thriving DE (Khanagha et al., 2022). Achieving the required level of trust to share knowledge between partners is crucial; this trust can be facilitated by joint problem-solving mechanisms (e.g. cooperative project development) that aid in finding a shared strategic goal between the partners without introducing the risk of losing competitive advantage by sharing information (Jingyao et al., 2021). From an infrastructure perspective, the DE must be based on principles of open innovation and participation and have the purpose of enabling all participants to benefit equally from their involvement (Brock et al., 2019). For partners, this involves sharing data, expertise, and technologies and being open to complementors and competitors alike (Liu et al., 2011) by introducing new routines or readjusting existing ones to provide the flexibility to respond to evolving ecosystem dynamics and adjust roles and strategies accordingly (Jingyao et al., 2021). Adjusting to this new openness can be challenging for partner firms as they still must maintain a clear understanding of their own identity and purpose while simultaneously collaborating with a variety of different actors to ensure close alignment and mitigate the risks of conflicts (Song et al., 2022; Wang & Miller, 2020).

### Focal firm level

For focal firms, effectively utilising digital resources and data is crucial for creating and maintaining a competi-

tive advantage. Innovating product and service offerings by embracing novel technologies such as AI or enriching solutions with Internet of Things-based value-added services underlines the need for firms to develop unique digital capabilities and resources to differentiate in the market (Sun & Wang, 2022). To innovate products and services, firms must look beyond their already existing knowledge and data and incorporate data across their ecosystems (Leone et al., 2021; Wagner, 2021). Increasing the foundation on which value and insights can be generated is a critical factor for reducing deployment costs as well as improving the performance of solutions (Burström et al., 2021). This can become a challenging task since joint value creation activities, especially with complementors with similar bargaining powers, are prone to tension as Wang and Miller (2020) highlight. Routines that facilitate resource sharing are key to overcoming these challenges by focusing on the opportunities that result from expanding the offered products and services to a larger audience (Fu et al., 2022). Incorporating resource orchestration routines, such as those proposed by Favoretto et al. (2022), aids focal firms in identifying, exploring, and exploiting opportunities presented by DEs. Adapting to these changes requires firms to change their organizational forms and be hyper-adaptive in incorporating digital technologies rapidly and demonstrating the flexibility needed for changes in BM designs (Volberda et al., 2021). Such malleable organizational designs are based on agile structures and are especially common in software industries (Hanelt et al., 2021). We propose that this approach will become a powerful tool for other organizations participating in DEs.

In response to our RQ regarding the DCs required by companies engaging in DEs, our study identifies specific capabilities at the ecosystem, partner firm, and focal firm levels. At the ecosystem level, the critical DCs include collaboration and openness to foster innovation and value co-creation among diverse actors. Establishing a shared ecosystem identity and employing adaptable governance mechanisms are essential to balance interdependence and ensure effective coordination among actors while maintaining flexible value-capture processes. At the partner firm level, companies need capabilities to align strategies and resources within the ecosystem, focusing on trust building and knowledge sharing through open innovation principles, which support cooperative project development and competitive collaboration. They must also possess the agility to adjust their organizational roles and routines to navigate evolving ecosystem dynamics. At the focal firm level, leveraging digital resources and insights from across the ecosystem is paramount. Capabilities such as innovating through emerging technologies like AI and the Internet of Things, developing resource-sharing routines, and adopting agile organizational structures are

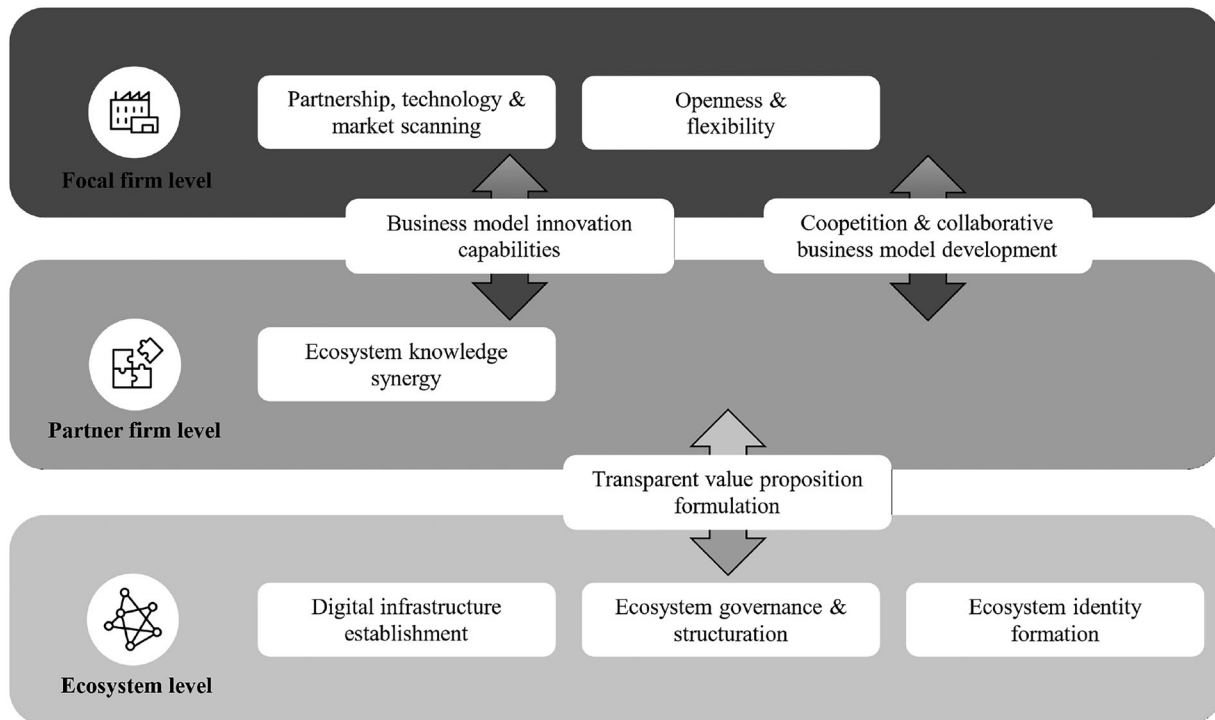


FIGURE 2 Multi-layered framework for dynamic capabilities in digital ecosystems.

crucial for maintaining competitive advantages in rapidly changing markets.

### Towards a framework for DCs in DEs

Based on the discussed results, this study presents a multi-level capability framework that captures how firms operate the dynamic business landscape within DEs across three interdependent levels: *focal firm level*, *partner firm level*, and *ecosystem level*. While prior research has largely focused on firm-level capabilities (Cenamor et al., 2017; Helfat & Raubitschek, 2018; Kindermann et al., 2022; Linde et al., 2021; Teece, 2007; Töytäri et al., 2018), this framework explicitly incorporates partner firm-level and ecosystem-level dynamics, providing a more comprehensive view of how organizations sense opportunities, seize advantages, and transform BMs within DEs.

The framework, as depicted in Figure 2, is structured in a layered format, distinguishing the unique roles and interdependencies of capabilities across the three levels while acknowledging the overlap necessary to enable firms to engage in coopetition, leverage ecosystem-wide knowledge, and co-evolve their BMs accordingly.

At the *ecosystem level*, capabilities focus on enabling and governing the broader ecosystem, ensuring that firms can engage in value co-creation and innovation while maintaining structural stability. These foundational capa-

bilities serve as the enabling conditions that allow firms to engage within DEs effectively, providing the necessary technological and regulatory structures for firms to build partnerships, innovate collaboratively, and capture value. Since the foundational capabilities at the ecosystem level set the stage for value co-creation activities, transparent value proposition formulation emerges as a key capability that is present at both the *ecosystem* and *partner firm levels*. Although at the ecosystem level this capability ensures that, from a macro-level view, all participants are aware of potential benefits and contributions of other actors, from a partner firm level this capability focusses on the formulation of each value contribution to the network to ensure visibility and alignment with potential partners.

At the *partner firm level*, capabilities emphasise interaction, alignment, and co-creation between firms within the ecosystem. This level can be seen as a bridge layer between ecosystem-wide governance and individual firm-level strategy. Together, these capabilities form the system to allow partner firms to create and deliver value both independently and collaboratively, ensuring their BMs align with broader ecosystem dynamics. As depicted in the framework, only one of the capabilities presented in this study is unique to partner firms, aligning with the intermediary role of partner firms within the ecosystem to foster and nurture a healthy environment within DEs. Again, some capabilities emerge at both the partner firm

and focal firm levels. Cooperation and collaborative BM development underscore the dual role of certain capabilities in navigating interfirm collaboration. At the *partner level*, firms must establish processes that allow competitors to exchange knowledge while protecting their proprietary assets when engaging with a plethora of potential partners for effective co-creation of value. In contrast, for *focal firms*, these capabilities entail effective management of individual relationships within the ecosystem to closely align value propositions and development of digital business strategies to foster new means of value co-creation without disregarding competition dynamics.

In a similar vein, BM innovation capabilities are present at both the *focal firm* and *partner levels*, yet their role and implementation differ based on a firm's positioning within the ecosystem. While at the *partner firm level* this involves co-creating value by leveraging multiple firms' strengths and knowledge, for *focal firms*, this means focussing on the continuous adaptation of the evolving ecosystem and the integration of these changes within their BMs. At the *focal firm level*, the remaining capabilities focus on strategic agility and adaptation, ensuring that individual firms can navigate the complexities of DEs while maintaining competitive advantage. In essence, the core capabilities at this level include the scanning of new avenues for partnerships, technologies, and market opportunities as well as a firm's capacity to openly adjust its strategy flexibly in response to ecosystem changes, allowing for continuous BM evolution and innovation.

These results refine the conceptualisation of DCs in DEs by demonstrating that sensing, seizing, and transforming are not firm-centric but multi-level processes embedded within a network of interdependent actors (Helfat & Raubitschek, 2018; Teece, 2018). Prior research has largely treated the DC view as an internal function (Töytäri et al., 2018), but our findings show that firms must develop ecosystem-wide capabilities to detect emerging opportunities, and governance shifts to adjust accordingly and keep a competitive edge (Thomas & Autio, 2020). This expands the strategic agility perspective by positioning the DC view as capabilities embedded in ecosystem structures rather than solely within firms (Nambisan, Zahra, et al., 2019). Embedding cooperation, collaborative BM development, and BM innovation activities at the intersection of focal and partner firms emphasises the strong link to value co-creation research (Kohtamäki & Rajala, 2016; Li et al., 2022; Pera et al., 2016; Ritala & Hurmelinna-Laukkanen, 2013; Storbacka et al., 2016). Unlike firm-centric BM approaches (Kohtamäki et al., 2019; Kohtamäki, Rabetino, et al., 2022; Sjödin et al., 2022), this study demonstrates that BMs dynamically adapt based on ecosystem structuration and interfirm dependencies (Linde et al., 2021).

## Future research directions

While the proposed framework advances the DC view in the context of DEs by emphasising a multi-level approach, it also reveals key areas requiring additional academic exploration. Thus, further research is needed at different levels of the ecosystem regarding each of the core themes our SLR unveiled, which will be presented in detail on the following pages.

Aligning ecosystem actors and building a structure to facilitate sharing data, resources, knowledge, and information to co-create new product and service offerings require an ecosystem vision that transparently demonstrates the value proposition and allows for simultaneous collaboration and competition in the ecosystem context (Arndt et al., 2021; Jingyao et al., 2021; Kolagar, Parida, et al., 2022). Opening firm boundaries and dissolving established industry boundaries further increases the complexity of aligning different actors for joint value co-creation (Hanelt et al., 2021; Langley et al., 2021; Wang & Bai, 2021). While there are several approaches for focal firms to organize DT-driven value creation in ecosystems, such as service- and platform-centric business architectures (Wagner, 2021), a product-centric view of value co-creation (Arndt et al., 2021), or a customer-centric view focusing on proof of value and close collaboration with customers to co-develop new solutions (Hiteva & Foxon, 2021; Leone et al., 2021; Schiavone et al., 2021; Sjödin et al., 2021), these approaches lack a holistic depiction of the changes required at the ecosystem level. While some studies address the issue of the ecosystem level by proposing the formation of an ecosystem mindset and shared identity (Bouncken & Kraus, 2022; Hanelt et al., 2021; Sehnem et al., 2022), they fall short in providing a framework or empirical evidence for how such identification processes could be facilitated in DEs at the ecosystem level. Thus, we propose the following research direction for future research:

Research Direction 1: DE research lacks a focus on the changes in identification processes at the partner firm and focal firm levels. Thus, more empirical research that focuses on the drivers and processes for forming a joint ecosystem mindset or identity is required.

Previous research has addressed the orchestration and delivery of value by leveraging internal and external knowledge through different approaches, such as facilitating DT for linking firms' stakeholders to extend the ecosystem (Leão & da Silva, 2021; Wang & Bai, 2021), collaboration with startups (Wagner, 2021), and multi-stakeholder cooperation with enterprises, universities,

research institutions, and governments (Hanelt et al., 2021; Sun et al., 2022). Building the necessary trust and joint vision is crucial for acquiring partners and incentivising collaborative relationships at the ecosystem level. As our results indicate, seizing capabilities to materialise the prospects of identified opportunities are required; these capabilities include co-competition capabilities, collaborative BM development, and ecosystem structuration capabilities. Research reflects these capabilities with conflicting approaches: strict governance structures, as highlighted by Jingyao et al. (2021), Kolagar, Parida, et al. (2022), Kolagar, Reim, et al. (2022), Makkonen et al. (2022), and Sjödin et al. (2022), and loosely structured approaches for ecosystem governance, as emphasised by Khanagha et al. (2022), Bouncken and Kraus (2022), and Volberda et al. (2021). We therefore propose the following future research direction:

Research Direction 2: The literature on DEs refers to conflicting approaches for ecosystem governance and structure. Empirical evidence and theoretical contributions to adaptable DE governance models are therefore needed.

While the role of ecosystem actors as a set of behavioural expectations is facilitated by recurring and predefined interactions (Bouncken & Kraus, 2022; Kolagar, Reim, et al., 2022), the role is subject to constant change, as the positions, roles, and interactions of actors must constantly adapt to the business environment (Hanelt et al., 2021). With the increased interdependencies between actors (Subramaniam, 2020), a constant rebalancing of power (Parker et al., 2016; Song et al., 2022), and less hierarchical organizational approaches for DEs (Volberda et al., 2021), the complexity of joint value capturing mechanisms in multidimensional revenue streams has further increased (Brock et al., 2019). Especially at the partner firm level, where partners can assume multiple roles, organizations at this level must inherit flexibility and adaptability. However, DE research has lacked a focus on both organizational theory and the routines necessary to provide the flexibility to adapt to role changes in ecosystems. We therefore propose the following future research direction:

Research Direction 3: DEs require partner firms to constantly adapt to changes in ecosystems and redefine their roles within these ecosystems. Empirical evidence is required that focuses on organizational designs that enable role flexibility at the partner level; research focusing on the routines that are required to implement these organizational changes is also required.

Firms at the partner level of an ecosystem must be open to leveraging their partnerships to successfully create meaningful relationships with firms at different levels of the ecosystem (Khanagha et al., 2022). Our results indicate that there are DCs that sense new opportunities through established digital infrastructure, as well as scanning and mapping opportunities, and seize capabilities built on connectivity and BM reconfiguration. While the research emphasises the importance of methods for collaborative data exchange, such as cooperative project development (Jingyao et al., 2021) or the adoption of principles of open innovation (Brock et al., 2019), it lacks a focus on the challenges at the partner firm level that transcend a dyadic view of interfirm relationships to reach interconnected BMs and business logics in DE. However, this view is necessary to understand how digital resources and data can be exchanged between partners to provide mutual benefits. We therefore propose the following future research direction:

Research Direction 4: DEs build upon the exchange of data and digital resources with different partners to create, capture, and deliver value. We propose a focus on routines, processes, and structures that mutually benefit partner firms through the lens of DEs as sociotechnical systems.

Collaborating with partners in DEs to offer new value propositions requires focal firms to be hyper-adaptive and constantly readjust BMs, processes, and resource configurations (Hanelt et al., 2021; Volberda et al., 2021); our results highlight multiple DCs to sense market and technology opportunities, formulate transparent value propositions, and materialise opportunities in collaborative and continuous BM innovation activities. As discussed, these agile structures are often found in software-based industries and enable firms to respond quickly to changes (Spagnoletti et al., 2022). However, adapting an agile approach in an ecosystem context becomes challenging as firms and teams are distributed over several organizations that often do not share the same goals (Figalister et al., 2019). We therefore propose the following research direction:

Research Direction 5: The existing literature on DEs emphasises the importance of flexible organization design but neglects the challenges arising from adopting agile-based approaches. Research focusing on the challenges of adapting to malleable organization designs in DE is required to build a framework for such organizational approaches for focal firms.

## IMPLICATIONS AND LIMITATIONS

The advent of DT has influenced firms to reshape their interactions and relationships in their approaches to creating, delivering, and capturing value through engaging in DEs. Establishing new means of interaction between ecosystem actors leads to new business processes and opportunities to create, deliver, and capture value, which is transforming BMs as they adapt to emerging opportunities. However, the implications of DEs for BMs are under-researched and require a focus on the DCs required to navigate the business landscape in a time of increasingly blurred firm boundaries. In the last 3 years, research around DEs has grown, and our findings indicate that both quantitative and qualitative research has been published in this period. In this study, we carried out an SLR to examine how firms' BMs are influenced by DEs and which DCs are required at different levels of the ecosystem. Our research contributes to the existing literature in three ways: (1) we shed light on the key contributions shaping the research at the intersection of DEs and the impact of DT on BMs to link the fragmented knowledge in various streams of the ecosystem as well as DT research to propose future research directions; (2) we propose 17 DCs in the digital age and discuss them at the three different levels of an ecosystem; and (3) we unveil five future research directions.

### Conceptual implications

Our study expands the DC framework to the context of DEs, where capabilities must operate across multiple interdependent actors rather than solely within firm boundaries. Traditionally, DCs focus on firm-specific actions for sensing, seizing, and transforming (Teece, 2007), but in DEs, these capabilities are shared and co-evolved across ecosystems, requiring firms to build and leverage collaborative relationships.

Sensing capabilities in DEs are not limited to a firm's internal scanning of its environment. Our findings show that sensing capabilities in DEs become a collective process, relying on shared data, platforms, and insights across ecosystem actors. Firms must align their sensing activities with those of their partners, making it necessary to develop architectural capabilities that facilitate real-time collaboration in identifying new technological opportunities and shifts (Dattée et al., 2018). This multi-actor sensing expands the DC framework by embedding sensing functions across all levels of ecosystems. Seizing capabilities evolve from a focus on internal resource realignment to an ecosystemic coordination.

In DEs, firms must collaborate to seize opportunities, often through cooperative innovation and resource shar-

ing with competitors and partners (Helfat & Raubitschek, 2018; Ritala & Sainio, 2014). This contrasts with traditional firm-centric views, highlighting the need for co-investment and joint seizing strategies across digital platforms, where collective value capture hinges on seamless coordination within the ecosystem (Cenamor et al., 2017; Jacobides et al., 2018). Our findings underscore the importance of these networked seizing activities, where firms must balance their own strategic interests with the broader ecosystem's success. This notion builds on the system of systems concept proposed by Porter and Heppelmann (2014, 2015), which highlights how interconnected systems, such as DEs, amplify the importance of synchronising capabilities across multiple platforms and external actors. It further extends the DC view to include managing interdependencies between firms' internal systems and the broader ecosystem itself, expanding on the view of Töytäri et al. (2018), who propose that DCs in dyadic relationships require alignment of mindset and capabilities across firm boundaries. Firms in DEs, as our results show, cannot act in isolation but must synchronise their capabilities beyond dyadic relationships in multilateral interdependent relations within DEs.

Transforming capabilities extend not only to adapting internal BMs but also to influencing and evolving the ecosystem's governance structures (Adner, 2017; Bouncken & Kraus, 2022). Firms must maintain flexibility in their roles within the ecosystem, shifting between orchestrating and participating as ecosystem dynamics change (Bogers et al., 2019). The ability to adapt to these roles while managing evolving ecosystems and the corresponding governance frameworks reflects an advanced understanding of transformation capabilities, positioning firms as critical shapers of the broader ecosystem structure. This transformation is not limited to individual firm changes but involves influencing the collective direction of the ecosystem, as firms often play dual roles in shaping governance and ensuring strategic alignment (Hannah & Eisenhardt, 2017). This capability to continually reconfigure both internal and external processes ensures the long-term alignment of firms within the ecosystem (Cenamor et al., 2017; Nambisan, Wright, et al., 2019). Access to knowledge-intensive resources, such as those typically possessed by startups and universities, is crucial for ensuring the competitiveness of individual firms as well as for the evolution of the ecosystem (Huikkola et al., 2022). This further strengthens the notion that transforming capabilities in DEs are multi-level, involving both internal reconfiguration and external ecosystem alignment, requiring constant role-switching, which is unique for DEs and highlights the importance of adaptive capabilities that allow firms to influence and adjust the structural evolution of both their internal processes and the ecosystem itself.

In DEs, DCs must encompass both internal transformation and external coordination, whereas traditional frameworks focus on internal capability building. The requirement to manage and influence external processes, such as governance structures and platform rules, demands a new understanding of DCs as both inward-facing and outward-facing capabilities. This shift emphasises that firms must engage in continuous reconfiguration not only of their internal operations but also of the broader ecosystem dynamics (Bogers et al., 2019; Teece, 2018).

The blurring of organizational boundaries in DEs necessitates a rethinking of how firms develop and deploy DCs. Recent research emphasises that as firms increasingly rely on platform-based models and shared infrastructures, the traditional firm boundary dissolves (Vuori & Tushman, 2024). Our findings contribute to this by illustrating that sensing, seizing, and transforming capabilities must not only be developed and deployed at the focal firm level but also encompass external actors within the ecosystem, allowing firms to identify opportunities across multiple actors. This expanded view aligns with Jacobides et al.'s (2018) work, which highlights the fluidity of ecosystem boundaries and the importance of co-innovation across interconnected firms.

Our study provides further theoretical contributions to the literature on BMs, particularly in the context of DEs. Traditional BM literature has focused primarily on firm-level innovation strategies or followed an interfirm-centric logic (Amit & Zott, 2001; Zott & Amit, 2010). However, our findings suggest that BM innovation in DEs is increasingly ecosystem driven. Firms must align their BMs with those of their ecosystem partners to co-create value, thus moving beyond firm-centric strategies to ecosystem-centric innovation. This finding is consistent with the growing recognition that changes in BMs in digital contexts require more than internal reconfiguration. Firms need to develop ecosystem DCs that allow them to coordinate, adapt, and evolve their BMs in tandem with other ecosystem actors (Westerlund et al., 2017). This is especially true in complex, multi-actor environments where platforms serve as intermediaries for value creation and capture (Cennamo & Santalo, 2013). Our findings demonstrate that successful changes in BMs in DEs require firms to continually assess and align their value propositions with those of the ecosystem to remain competitive. This contribution extends the work of Jacobides et al. (2008) and Adner (2017), who emphasise the co-evolution of organizational capabilities and BMs in ecosystems. Our research adds to this by showing that BM transformation in DEs is not a solitary effort but rather a collective process driven by the dynamic interplay of ecosystem actors.

## Managerial implications

DEs have profound implications for BMs, necessitating a shift in management practices. As Adner (2017) emphasises, successful ecosystems regard value creation and capture mechanisms of partner firms as just as critical as the focal firm's BM. Based on our findings, this importance is reflected in the principles of collaboration and openness. Our research reveals the pivotal role of interfirm collaboration for focal firms, as well as the importance of successfully leveraging partnerships and fostering a culture of trust. Forming a mutual vision for partner firms and building an ecosystem mindset depend on the principles of open and transparent interactions and inclusive leadership practices. These principles require a distinct ecosystem strategy, as our findings have demonstrated. Since actors in DEs may be aware of their dependencies in value creation, capture, and delivery, it may not be obvious that they are part of an ecosystem as well as pivotal building blocks in the value proposition of other actors within the same ecosystem. In the age of DEs, firms are no longer isolated entities; instead, they are part of an interconnected network that requires new principles of collaboration and openness to foster the health and functioning of the ecosystem to successfully create, deliver, and capture value. This interconnected approach must be embedded by managers in BMs to emphasise and align the role of the ecosystem with a firm's strategy and value propositions (Adner, 2017; Cusumano et al., 2019).

Developing new digital products and service offerings hinges on the ability to integrate increasingly digital resources and data. At the ecosystem level, this means that practitioners must implement an integrated data pipeline into their firms to successfully exchange data with a plethora of partners while considering mutual benefits and providing incentives to participate in the data exchange. Simultaneously, firms must be able to identify opportunities to engage in data exchange with the consideration of responsible data-sharing practices enabled by secure digital resource orchestration routines and practices. Focal firms must integrate new means of capturing, storing, and providing data for their ecosystems (Lee et al., 2019; Lis & Otto, 2020), and ecosystems must provide both transparent and healthy incentivisation models to warrant the efforts of the participating firms (Sun & Zhang, 2021; Valdez-De-Leon, 2019). Thus, participating companies must cement the role of the ecosystem in their BMs to reflect the importance of this key element for fulfilling value propositions. Managers must dedicate resources to identifying and cultivating these possibilities for data exchange.

Finally, our findings highlight the relevance of agile and adaptable structures at all ecosystem levels. These agile and adaptable structures involve agile management practices that enable firms to rapidly respond to changes in an ecosystem by cultivating a flexible organizational structure to both participate in and change their roles within the ecosystem. As ecosystems evolve, change, and adapt to both internal and external forces, firms must implement adaptable governance structures that find a balance between rigid formal guidelines and principles and loosely structured couplings. Balancing power dynamics between different actors is crucial, and managers of both partner firms that complement the ecosystem and orchestrating entities must be aware of different power positions within DEs. Managing these imbalances requires acceptance of these power imbalances and proactive action to support both ecosystems and orchestrators.

## Limitations

Despite the contributions of this study, several limitations must be acknowledged that can guide future research. First, while the methodological approach of an SLR provides a comprehensive synthesis of academic work on DCs in DEs, it inherently limits the inclusion of emerging industry practices and unpublished insights from key industries. Studies have shown that SLRs tend to favour mature, peer-reviewed research, potentially overlooking more recent developments in fast-evolving sectors (Tranfield et al., 2003). Consequently, future research could incorporate longitudinal case studies or larger empirical datasets to capture the evolving nature of DCs in DEs (Autio et al., 2018).

Second, the study may be limited by its sectoral focus. Although our findings are drawn from a diverse range of industries, the dataset has an inherent emphasis on digitally advanced sectors, thus limiting its applicability to industries with lower levels of DT. Bogers et al. (2019) suggest that ecosystemic DCs vary significantly across industries, particularly in less digitally mature contexts, where the role of digital platforms is less prominent (Bharadwaj et al., 2013; Lee & Roh, 2023; Subramaniam, 2020). Future research can benefit from examining these industries in particular, as well as from cross-comparisons between different industries.

Lastly, while this study offers a conceptual analysis of DCs in DEs, it lacks quantitative validation. Although the conceptual framework contributes to understanding which DCs operate across firm boundaries, the complexity of measuring multi-level ecosystem capability is acknowledged. Existing literature points to the difficulty in operationalising DCs in an ecosystem due to their

interdependent nature, which complicates traditional performance measurement (Bogers et al., 2019; Cenamor et al., 2017). Developing quantitative tools to assess the impact of ecosystemic DCs on value creation, capture, and delivery would provide more robust empirical evidence.

## Concluding remarks

In this study, we explored how DEs reshape BMs by influencing how firms create, deliver, and capture value in response to DT. As DEs continue to blur firm boundaries and redefine interactions between ecosystem actors, understanding the DCs needed to navigate this evolving landscape remains critical. Our SLR synthesised recent research at the intersection of DE, DT, and BM research, offering a structured perspective on this field. Specifically, we identified 17 DCs essential for firms operating within DEs and examined their role across different ecosystem levels while also presenting a framework that emphasises the interdependences and overlap between the DCs required at these levels. Additionally, we proposed five key research directions to advance knowledge in this domain. Linking fragmented insights from DE, BM and DT research, our study provides a foundation for future exploration and supports firms in strategically adapting to the complexities of DEs.

## AUTHOR CONTRIBUTIONS

**Felix Volz:** Conceptualisation; methodology; formal analysis; investigation; writing—original draft; writing—review and editing; visualisation. **Christopher Münch:** Conceptualisation; methodology; validation; investigation; data curation; writing—original draft; writing—review and editing; supervision; project administration. **Christoph Küffner:** Validation. **Evi Hartmann:** Validation.

## ACKNOWLEDGEMENTS

Open access funding enabled and organized by Projekt DEAL.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

**How to cite this article:** Volz, F., Münch, C., Küffner, C., & Hartmann, E. (2025) Digital ecosystems and their impact on organizations—A dynamic capabilities approach. *International Journal of Management Reviews*, 27, 398–419. <https://doi.org/10.1111/ijmr.12396>