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Digital entrepreneurial ecosystems: A systematic literature review

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ABSTRACT

The concept of digital entrepreneurial ecosystems (DEEs) has been developed to systemically analyze entrepreneurship in the digital age. Research on DEEs is, however, still dispersed, and there exists ambiguity in this relevant field. With the aim of creating a more comprehensive understanding of DEEs, we conduct a systematic literature review that outlines the current state of research and consolidates the literature at the intersection of digital entrepreneurship and entrepreneurial ecosystems. Since DEEs have been explored from different perspectives and given the adoption of various attributes, we propose a conceptual framework presenting a set of characterizations corresponding to principal ecosystem attributes. By offering a range of characteristics, our framework provides an inclusive picture of the different possible types of DEEs, offering promising avenues for future research.

1. Introduction

In addition to placing the entrepreneur rather than the incumbent firm at the center of investigation (Stam, 2015), the entrepreneurial ecosystem (EE) approach considers the broader entrepreneurial context within which entrepreneurship takes place (Brown and Mason, 2014) and examines wide-ranging socioeconomic, technological, and cultural dimensions and impacts (Audretsch et al., 2018, 2019). While the literature on EEs has focused on the spatial dimensions, emphasizing the relevance of regional proximity (Acs et al., 2017; Brown and Mason, 2017), it is imperative to consider also the technological context prompted by digitalization. By transforming the nature of processes and outcomes in entrepreneurship, digital technologies engender a reconsideration of entrepreneurial activities (Nambisan, 2017; Nambisan et al., 2017; Yoo et al., 2012). Moreover, digitalization has changed the locus of entrepreneurial opportunities and practices, and hence the dynamics in EEs (Autio et al., 2018), suggesting the need to explore digital entrepreneurial ecosystems (DEEs).

Sussan and Acs (2017) proposed a framework for DEEs, locating digital entrepreneurship within the context of users, platforms, and institutions. The framework was then refined by Song (2019) and presents four concepts: (1) digital user citizenship, (2) digital technology entrepreneurship, (3) digital infrastructure governance, and (4) digital multisided platform. While other scholars also recognized the need to explicitly investigate DEEs (e.g., Du et al., 2018; Elia et al., 2020; Li et al., 2017), existing studies have rather examined the impact of digitalization on entrepreneurship as well as the interlinkages within ecosystems. Due to the heterogeneity of these studies, there is no consistent understanding of DEEs, creating a gap in our systemic understanding of entrepreneurship in the digital age. In order to advance our knowledge on DEEs, it is necessary to examine adjacent literature streams which have considered on the one hand the effect of digitalization on entrepreneurship and on the other hand the nature of EEs in a digital context. This study aims to consolidate and enrich the literature on DEEs by providing a foundation of what characterizes DEEs, how DEEs differ from EEs, and which added value the concept of DEEs offers.

The concept of DEEs subsumes digital entrepreneurship and entrepreneurial ecosystems, which are deemed the roots of the term. Accordingly, it is the overlap between these two concepts that provides a comprehensive understanding of a DEE. Using a systematic literature review, this paper reviews the current state of research on DEEs to provide a comprehensive understanding of these ecosystems. Acknowledging the uniqueness and distinctive peculiarities of ecosystems, we propose a conceptual framework presenting a set of characterizations corresponding to principal ecosystem attributes which are useful to understand DEEs. By proposing a range of characteristics, our framework provides an inclusive picture of the different possible types of DEEs, offering promising avenues for future research.

Our systematic literature review reveals that authors attribute distinct features to DEEs, widening the conceptual ambiguity. We

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contend that a more applicable definition, derived from our literature review, provides more conceptual clarity and acts as a base upon which to develop a coherent research field. Furthermore, a two-by-two typology that delineates four forms of DEEs is presented. Based on the ecosystems described in the selected literature, four types of DEEs can be identified according to the following two dimensions: the degree of autonomy in governance and the degree of collaboration within the ecosystem. These dimensions act as boundaries for a range of ecosystems which are depicted by the typology. In addition to the aforementioned contribution to the literature, our typology thereby permits the development of targeted managerial implications.

The remainder of our paper is structured as follows. The next section provides the theoretical background of the constituting terms of entrepreneurial ecosystems and digital entrepreneurship. The methodological approach of our systematic literature review is then explained in detail in Section 3. Subsequently, the findings and interpretations of our results are presented. The paper concludes with an agenda delineating future directions for research on DEEs.

2. Theoretical background

2.1. Entrepreneurial ecosystems

With the aim of understanding entrepreneurship holistically, studying EEs has emerged as a promising area of research. Analogies to biological ecosystems have been proposed to create the concept of EEs. Introduced by Moore (1993) in management research, the metaphor reflects complex interactions and evolving, nonlinear ecosystem properties (Colombelli et al., 2019; Iansiti and Levien, 2004). Correspondingly, in entrepreneurship, interactions take place within a network of interdependent actors and entities (Cavallo et al., 2019; Kuratko et al., 2017). Similar to the interaction of biotic and abiotic components in natural ecosystems, people interact with the infrastructure and culture in EEs (Isenberg, 2016). Likewise, the systemic conditions such as networks of entrepreneurs, leadership, finance, talent, knowledge, and support services are at the core of the ecosystem, and the framework conditions enable such interactions within a social context (Stam and Spigel, 2018).

The concept of EEs is also employed by practitioners (Cohen, 2006; Feld, 2020; Isenberg, 2010; Napier and Hansen, 2011). Popular among policymakers, the framework developed by Isenberg (2010) consists of five pillars: policy, finance, culture, support, human capital, and markets. Several researchers have attempted to provide a definition for EEs. Brown and Mason (2014: 5) define them as a "set of interconnected entrepreneurial actors, entrepreneurial organizations, institutions and entrepreneurial processes which formally and informally coalesce to connect, mediate and govern the performance within the local entrepreneurial environment". Acs et al. (2014: 479) acknowledge EEs as "dynamic, institutionally embedded interactions between entrepreneurial attitudes, ability, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures". Stam (2015) recognizes the interdependencies of actors, emphasizing that their coordination enables productive entrepreneurship. This entrepreneurial ecosystem perspective accords the role of the interdependence of actors, congruent with the regional development and strategy literature (Brown and Mason, 2017; Buratti et al., 2022).

Unlike industrial districts or clusters, the focus of EEs is not on a specific industry but considers wide-ranging socioeconomic, technological, and cultural dimensions (Audretsch et al., 2018). The entrepreneurial ecosystem approach highlights value creation within regional boundaries (Acs et al., 2017) as well as the importance of an established knowledge base which supports the emergence of an ecosystem in a certain place (Brown and Mason, 2014). Furthermore, EEs incorporate evolutionary characteristics shaped by different institutional and cultural settings (Mack and Mayer, 2016), which suggests an evolution toward a digital entrepreneurial ecosystem.

2.2. Digital entrepreneurship

When exploring the effect of digitalization on entrepreneurship, it is necessary to understand the implications of the digital transformation. Defined as the use of digital technologies to enable major business improvements (Fitzgerald et al., 2014) and organizational transformation (Liu et al., 2011), the digital transformation accentuates the (disruptive) effects of digital technologies for businesses (Nambisan et al., 2019a). Consequently, digital technologies are not only considered to be another context but also compel new theorizing on entrepreneurship (Nambisan, 2017; Zaheer et al., 2019). By transforming the nature of uncertainty of processes and outcomes in entrepreneurship, digital technologies engender a reconsideration of entrepreneurial activities (Audretsch et al., 2022; Nambisan, 2017; Nambisan et al., 2017; Yoo et al., 2012). On the one hand, entrepreneurial processes and outcomes become more fluid and less bounded (Nambisan, 2017). On the other hand, entrepreneurial agency is deemed less predefined and more distributed (ibid.).

Nevertheless, due to their generative nature, digital technologies enable scalable innovations and drive unprompted change (Zaheer et al., 2019). Inspiring new entrepreneurial opportunities (Ferreira et al., 2019), digitalization stimulates entrepreneurial activity, competition, and innovation, which in turn enhance digital transformation (Galindo-Martín et al., 2019). Digital technologies enable entrepreneurs to modify product development and experiment quicker, which results in more dynamic business models and continuously evolving digital entrepreneurial processes (Kraus et al., 2018). Moreover, organizational agility is enabled (Sambamurthy et al., 2003), and new work structures emerge, supported by digital infrastructure (Nambisan et al., 2019a). In addition, digital artifacts and platforms promote incremental and nonlinear entrepreneurial directions (Nambisan, 2017). Steininger (2019) views the role of information and communication technology as that of a facilitator, mediator, outcome, and enabler of new business models in digital entrepreneurial processes.

Hence, entrepreneurship sees several developments arising from digitalization, ranging from new resulting opportunities to alterations of existing businesses and changes of business models to account for digital environments (Kraus et al., 2018). Scholars have proposed different definitions to explain these novel forms of processes as digital entrepreneurship. Hull et al. (2007: 293) understand digital entrepreneurship as "a subcategory of entrepreneurship in which some or all of what would be physical in a traditional organization has been digitized". The authors differentiate this concept from traditional entrepreneurship in terms of products, marketing, and workplaces (Kraus et al., 2018). Davidson and Vaast (2010): 2) perceive digital entrepreneurship as "the pursuit of opportunities based on the use of digital media and other information and communication technologies". The authors emphasize the interactions and networks of relationships within the digital context compared to just focusing on the entrepreneur, highlighting that digital entrepreneurship relies on the resources in the surrounding environment rather than only the entrepreneur's abilities. This collective view has also been taken by Spiegel et al. (2016), who underlines the importance of resources from professional and social networks, as well as by Du et al. (2018), who take a community level perspective, asserting that a supportive ecosystem is requisite for the success of digital entrepreneurship.

Similarly, Zaheer et al. (2019) emphasize the role of the pervasively connected environment and saturated technology usage which support

the transformation of business models. The authors base their notion on the development of the literature on digital entrepreneurship, where the focus has deviated from individuals and teams to ecosystems. Likewise, Srinivasan and Venkatraman (2018) suggest a network-centric approach to understand digital entrepreneurship, as the actions of entrepreneurs and their coordination within platforms are crucial to their success. The importance of network effects is prevalent in the adjacent literature on industry or external platforms (Gawer and Cusumano, 2014), two-sided markets (Rochet and Tirole, 2006), and multisided platforms (Evans and Schmalensee, 2016). As an overarching term to describe digital activities in business, politics, and society, the concept of the digital platform economy is thereby used to refer to the dependence of platforms on the digitization of value creation (Kenney and Zysman, 2016).

Furthermore, Sahut et al. (2021: 1162) understand digital entrepreneurship as "the process of entrepreneurial creation of digital value through the use of various socio-technical digital enablers to support effective acquisition, processing, distribution, and consumption of digital information". Recent studies have nevertheless mentioned the role of non-market values in digital entrepreneurship, where digital technologies allow new forms of collaboration for economic as well as social value (Abubakre et al., 2021).

Given the disparate nature of research exploring on the one hand the broader environment in which digital entrepreneurship takes place and on the other hand the impact of digitalization on the entrepreneurial ecosystem, a systematic review of the literature consolidating our knowledge seems timely.

3. Methodology

With the aim of creating a comprehensive understanding of DEEs, it is necessary to explore the literature that covers this phenomenon. Investigating the current state of research and synthesizing what has been studied is an essential step to advance the concept of DEEs. To fulfill this aim, a systematic review of the literature is conducted. We followed the suggested approach of Fisch and Block (2018) to organize our study and to coherently structure the knowledge on DEEs. The review consisted of three steps (see Fig. 1): (1) planning, (2) conducting the review, and (3) reporting and dissemination (Tranfield et al., 2003). First, the keywords and search terms which make up the concept of DEEs were identified. We initially divided the term into 'digital entrepreneur', 'entrepreneurial ecosystem', and 'digital ecosystem'. Subsequently, based on the search results, we followed an iterative process and adapted the search terms (Kuckertz and Block, 2021). As the research on digital ecosystems is quite broad and extends beyond the relevancy of entrepreneurship studies, we focused our systematic literature review and conducted two searches using the terms 'digital* AND entrepreneur*' and 'entrepreneur* AND ecosystem', respectively.[1]

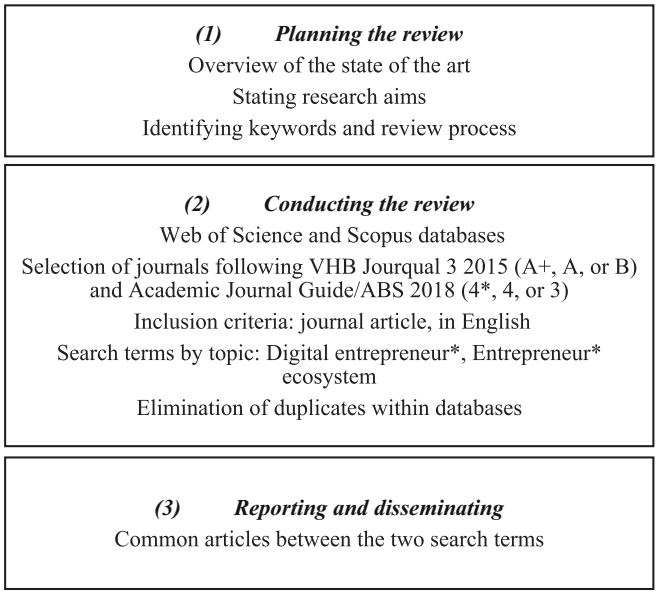

Fig. 1. Systematic literature review process.

We acknowledge prior literature reviews (Kuckertz and Block, 2021) and build our review upon previous studies which have already defined and systematically analyzed the literature of the selected terms. For instance, the literature on EEs has already differentiated the concept of EEs from similar concepts such as clusters, business ecosystems, networks, and environments (Brown and Mason, 2017; Cao and Shi, 2021; Fernandes and Ferreira, 2022; Secundo et al., 2020), so it is not necessary for this review to substitute this term. Similarly, the term 'digital' has been thoroughly explored separately and delineated from descriptions such as technology, virtual, or internet-based, just to name a few (Kollmann et al., 2022; Steininger, 2019; Zaheer et al., 2019). The selected terms were then searched for in the Web of Science database as well as the Scopus database to assure completeness. The search was filtered so as to have the terms present in the topic (title, abstract, keywords), only articles as document types, only publications in English, and publication years extending only to the end of 2021. Only high-quality journals evaluated as A+, A, or B according to the VHB Jourqual (JQ) 3 rating from 2015 and journals rated as 4*, 4, or 3 according to the Academic Journal Guide/ABS from 2018 were selected. The limitation of the journals served as a quality assessment which is followed in systematic reviews in the management field (Tranfield et al., 2003). The search results from the Web of Science and Scopus database were combined and duplicates were removed.

The final sample comprised 323 results for 'digital* AND entrepreneur*' and 427 results for 'entrepreneur* AND ecosystem'. Since the aim of this study is to explore the concept of DEEs which lies at the intersection of these search terms, the overlapping literature was identified. The resulting 46 articles made up the final sample, which was then thoroughly investigated (see Fig. 2 and Appendix 1 for the list of articles included in the review).

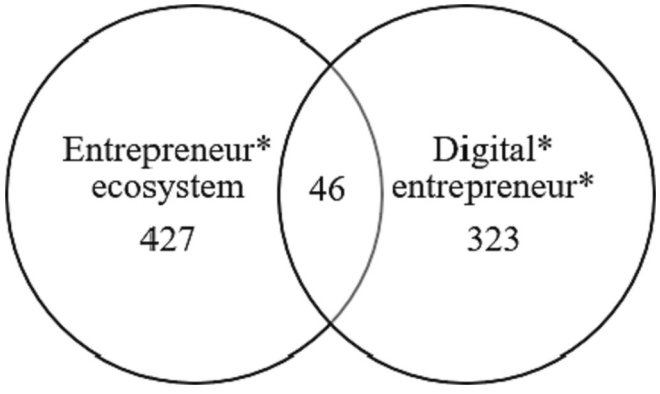

Fig. 2. Selected literature.

[1] To account for the comprehensive understanding of digital entrepreneurship, and based on Nambisan (2017), complementing our search term 'digital* AND entrepreneur*', we ran additional searches on 'digital technology', 'digital artifacts', 'digital platforms', and 'digital infrastructure' as related elements. Since we are interested in the intersection with 'entrepreneur* AND ecosystem', no additional articles from these additional searches were relevant and there was no added value to our initial selection. Hence, we finally only utilized the terms 'digital* AND entrepreneur*' and 'entrepreneur* AND ecosystem' for our systematic review of the literature.

4. Findings

4.1. Bibliometric findings

The extant literature has paid little attention to the intersection between entrepreneurship, ecosystems, and digitalization. Growth of the literature in various directions is, however, counteracting the coherent advancement of the research (Kraus et al., 2021). Our systematic literature review helps to map the field of DEEs by synthesizing the literature and providing a common understanding. Examining the final article selection, we observe that most of the articles were published within the years 2019 and 2021, with the earliest article from 2010, one from 2015, and one from 2016 (see Fig. 3). Out of the 46 articles identified, 20 papers are conceptual, 15 papers use a qualitative research design, 9 papers use a quantitative research design, and 2 papers use a mixed-methods approach (see Fig. 4). Moreover, the article selection shows that DEEs have been considered from different interdisciplinary perspectives.

Upon delving into the literature, we review firstly the themes introduced by the authors. Fig. 5 visualizes the co-occurrence of terms from the abstracts and titles of the selected articles. The terms illustrated occur at least five times within the abstract or title of all of the articles. We have filtered out filling terms that are of no relevance to this analysis such as 'study', 'research', or 'literature'. Each term is represented by a circle, with the size indicating the corresponding co-occurrence. The terms are grouped into clusters; the closeness demonstrates the frequency of their co-occurrence. As illustrated, the term 'ecosystem' occurs the most and is located relatively in the center. This shows that it is considered an umbrella term which can be generalized and used in various contexts. The term 'entrepreneurial ecosystem' has also a high occurrence and is strongly related to 'digital entrepreneurship' and 'innovation'. 'Innovation' is nevertheless a central terminology. The term 'platform' occurs often as well. It is situated in a separate cluster with a clear connection to 'market' and 'ecosystem' but a thinner connection to 'entrepreneurial ecosystem'. The term 'dee' or digital entrepreneurial ecosystem occurs less often and is situated farther away. This gives on the one hand an indication that the term is still not common in the literature. On the other hand, the apparent connection to 'entrepreneurial ecosystem' and 'digital entrepreneur' confirms the origin of this literature.

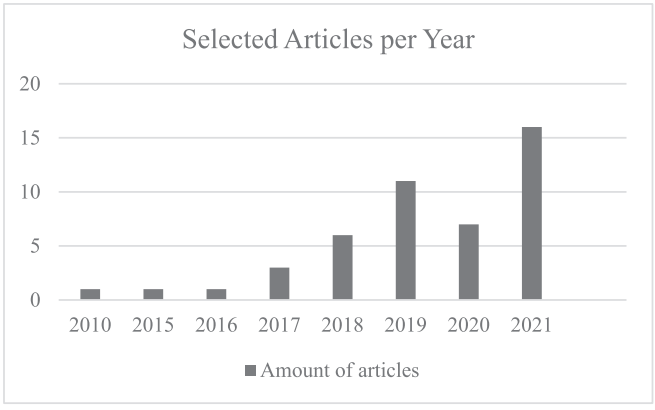

Fig. 3. Selected Articles per Year.
The year in which the article was available online is considered ("online first").

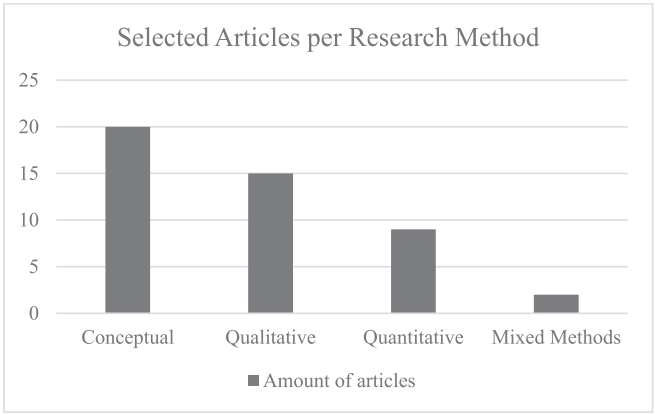

Fig. 4. Selected Articles per Research Method.

4.2. Streams of research on digital entrepreneurial ecosystems

Our review of the literature reveals that scholars have taken different perspectives when exploring the intersection of digital entrepreneurship and EEs. Relevant to our investigation of DEEs, the literature can be clustered into three research streams. The first research stream includes the explicit literature on DEEs and the initial exploration of the terminology. Recognizing the need to explore EEs in the digital context, Sussan and Acs (2017: 56) proposed that a digital entrepreneurial ecosystem is composed of "Schumpeterian entrepreneurs creating digital companies and innovative products and services for many users and agents in the global economy". By integrating the literature on digital ecosystems and EEs, the authors construct a framework which consists of two biotic entities (users and agents) and two abiotic components (digital infrastructure and digital platforms). This framework was subsequently refined by Song (2019), who delineates the difference between the user and the agent and sets conditions for a sustainable digital entrepreneurial ecosystem in which user privacy is protected, competition on platforms is encouraged, digital infrastructure is secure, and third-party agents increase platform efficiency. The author thereby highlights the role of digital platforms as enablers of entrepreneurship and suggests that the DEE concept initiates discussion on the impact of digital technologies on EEs.

On another note, Du et al. (2018) explore how a DEE emerges, comparing it to the formation of a meta-organization. Based on a case study of Zhongguancun, China, in a DEE labor is divided into institutional supporters, co-working space operators, and niche players, and efforts are unified to create a common infrastructure as well as an entrepreneurial culture (ibid.). Elia et al. (2020) discuss the digital entrepreneurial ecosystem based on four dimensions (digital actors, digital activities, digital motivations, and digital organization), interpreting the DEE construct as a collective intelligence system. Furthermore, Torres and Godinho (2022) take a closer look at the levels of necessity of each of the DEE elements and identify digitally enabled unicorns as the output and suitable measure of DEE performance.

The second research stream includes the research based on the EE literature which considers the impact of digital technologies in various contexts but does not recognize the studied ecosystems as DEEs. For instance, Autio et al. (2018) view EEs as a tool that supports the digitalization of the economy by exploiting digital affordances to facilitate entrepreneurship. Bouncken and Kraus (2022) explore the role of digital technologies in enabling coupling within EEs, and Song et al. (2022) explains how a traditional market can be transformed into an EE with the help of digitalization and an e-commerce strategy.

The studies grouped in the third research stream discuss the interplay of digitalization and ecosystems by using different terms when defining the ecosystems. Some of the utilized terms include 'innovation ecosystems' (Radziwon et al., 2022; Yildirim and Tunçalp, 2021), 'digital platform (-based) ecosystems' (Fan et al., 2021; Nambisan et al., 2019b; Nambisan and Baron, 2021), 'platform ecosystems' (Cutolo and Kenney, 2021; Eckhardt et al., 2018), 'sharing economy platforms' (Zeng et al., 2021), and 'disruptive innovation ecosystems' (Palmié et al., 2020). Other articles utilize ecosystems or platforms as a general term. The terms are in some cases used distinctly and in others interchangeably.

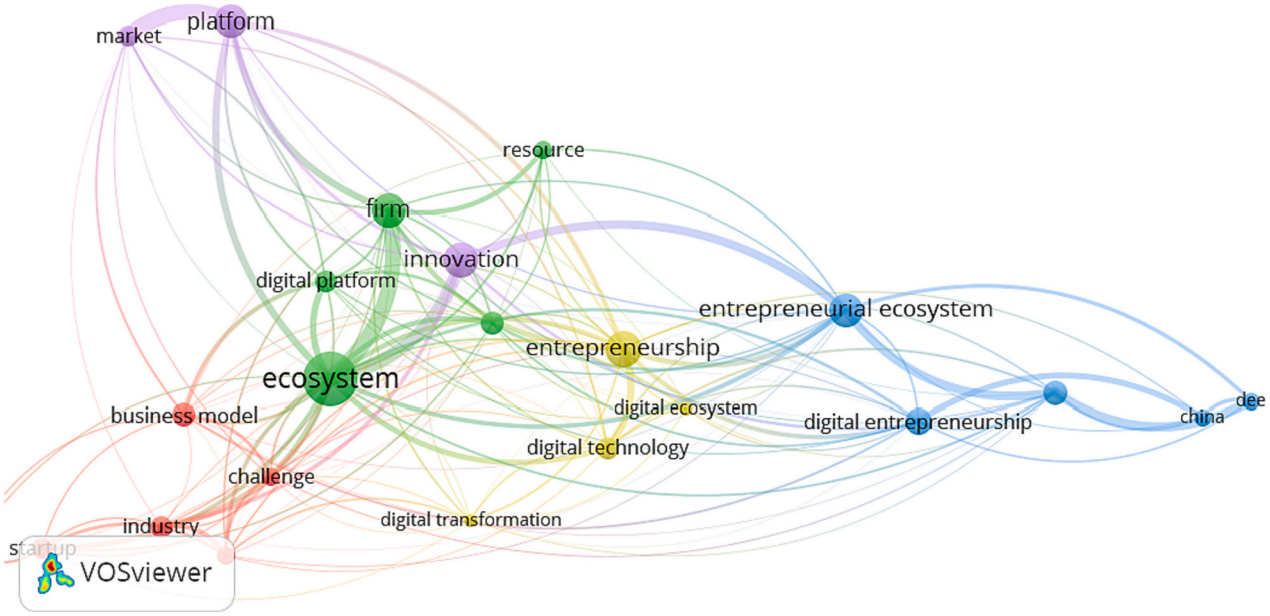

Fig. 5. Co-occurrence of terms.

One implication is that there is no clarity in the literature with regards to a common understanding of EEs in a digital context. Another interpretation is that different ecosystems share similarities with respect to form, actors, processes, etc. It is hence imperative to create a comprehensive set of characteristics which could describe DEEs while recognizing the differences and various directions these ecosystems could take.

4.3. Conceptual framework

A characteristic which is pertinent to ecosystems as well as DEEs is the uniqueness and the distinctive peculiarities of every ecosystem (Brown and Mason, 2017). Similar to EEs, DEEs differ in forms, governance, actors, and norms (Bounken & Kraus, 2022). This diversity is, however, increased by new opportunities, collaboration forms, and processes enabled by digitalization (Nambisan, 2017; Torres and Godinho, 2022). Consequently, there is not a one-size-fits-all approach to DEEs, nor is there a fixed set of characteristics. Ecosystems are dynamic in nature (Brown and Mason, 2017; Cantner et al., 2021; Nambisan et al., 2018), and so it is only consistent to adopt a flexible perspective when describing them. Following our aim to provide a holistic understanding of DEEs, we create a conceptual framework showing a set of characterizations corresponding to principal ecosystem attributes that are useful to understand DEEs (see Fig. 6). Investigating the ecosystem attributes rather than just peripherally describing the concept (Spigel,

Ecosystem Attributes	**Characterizations**			
Governance	Self-organized *(without a controlling entity)*	Distributed *(agency among several members)*	Less predefined *(undetermined)*	Platform owned *(leader and regulator)*
Actors	Aligned *(central value proposition)*	Mutually dependent *(co-specialization)*	Autonomous *(no hierarchical structure)*	
Resources	Shared *(generic knowledge base)*	Allocated *(mediated by institutions)*	Integrated *(heterogeneous resources and actors)*	
Architecture	Modular *(flexibility in resource use)*	Structural openness *(ease of entry to the ecosystem)*		
Complementarity	Offerings *(products or services)*	Resources *(technologies and knowledge)*	Actors *(roles and activities)*	
Reach	Across geographical borders *(geographically dispersed)*	Cross-sector *(across industries)*	Beyond organizational boundaries *(interfirm collaboration)*	
Identification Process	Ecosystem identity *(system-level goal)*	Founder-based identity *(influenced by the entrepreneur)*	Platform identity *(platform rules and structure)*	No fixed identity *(resources rather than identity as foundation)*

Fig. 6. DEE conceptual framework.

2017) serves as a fundamental step in explaining DEEs. The framework was derived inductively based on our systematic literature review. The ecosystem features mentioned in the literature were collected and considered according to their relevancy and significance to DEEs. The various descriptions given were then categorized in such a way that DEEs can be differentiated and clustered. Subsequently, the characterizations helped to delineate different forms of DEEs and to depict the nature of each of their attributes. We explore in more detail the role and characterization of each DEE attribute in the following subsections.

4.3.1. Governance

Governance structures play a central role in the resulting performance of ecosystems (Bouncken and Kraus, 2022); it is hence imperative to look at the various control mechanisms that DEEs can have. DEEs can be self-organized in the sense that they lack a controlling entity (Elia et al., 2020). In this case, the digital infrastructure supports their collective interaction and emergence, instead of bureaucracy coordinating the activities (ibid). DEEs could nonetheless support shared and distributed agency as well as processes and outcomes (Zaheer et al., 2019). The actors in such ecosystems are coupled with distributed governance and complementarities (Acs et al., 2021). Nevertheless, as a consequence of digitalization, outcomes have become less bounded and agency less predefined in innovation and entrepreneurship (Nambisan, 2017). This is similarly reflected in the governance of DEEs, which can remain less predefined because of the fluidity of the digital context. Conversely, DEEs can be platform-owned when within the ecosystem, the platform acts as a private regulator (Cutolo and Kenney, 2021). By taking the role of owners, platforms control adverse circumstances in an effort to reap higher value from the system (Boudreau and Hagiu, 2009; Evans, 2012). As a central player, the platform leader can thus orchestrate the different ecosystem members and activities (Nambisan et al., 2019b).

4.3.2. Actors

The literature on DEEs agrees on the presence of various actors with different roles in the ecosystem. The relation between the actors is, however, perceived differently. One perspective highlights the importance of the alignment of diverse actors following a central value proposition (Adner, 2017). Another recognizes actors as mutually dependent to different extents relative to their co-specialization and complementarities (Jacobides et al., 2018). In addition, the digital context enables greater flexibility and autonomy for actors, rendering hierarchical organizational structures dispensable for the coordination of activities (Cennamo et al., 2020).

4.3.3. Resources

The stance on resources is another essential component in DEEs. The shared set of resources redefines the nature of ownership and governance (Nambisan et al., 2019b). By supporting a generic shared knowledge base (Zaheer et al., 2019), DEEs empower entrepreneurial development. Nevertheless, as a resource allocation system (Acs et al., 2014), DEEs, supported by governance mechanisms, make use of innovations to digital platforms to support entrepreneurial activities (Siaw and Sarpong, 2021). In addition, as a driver of value co-creation, resource integration facilitates competition and collaboration (ibid.) in DEEs. Resource integration is necessary in ecosystems with heterogeneously distributed resources and multi-actor networks (ibid.)

4.3.4. Architecture

The digital infrastructure constitutes a founding pillar of a DEE (Sussan and Acs, 2017). However, the architecture could differ depending on the focus of the ecosystem. DEEs can on the one hand converge around a modular architecture which facilitates re-using resources and driving economies of scope (Gawer, 2014). Additionally, modularity implies adaptable resource configurations which facilitate entrepreneurial processes and enable flexibility in value creation (Nambisan et al., 2019b). On the other hand, DEEs can accentuate a structurally open architecture which allows more actors to contribute with their innovations (Kraus et al., 2018).

4.3.5. Complementarity

The digital infrastructure supporting DEEs enables the development of complementarities in an ecosystem. In one way, the ecosystem can support smaller firms to create product or service offerings which complement those of the platform (Nambisan and Baron, 2021), thus expanding the platform's market options and value (Cennamo et al., 2020). In another way, digital platforms are used to access complementary resources, enabling complementarities of technologies within the DEE (Bouncken and Kraus, 2022). Also, the different roles taken on by the actors accrue complementarities in their activities and outcomes (Nambisan et al., 2018). In that sense, the relationship between the platform and actors in the DEE is complementary as well (Jacobides et al., 2018).

4.3.6. Reach

By challenging spatial boundaries (Autio et al., 2018), digitalization enables a wider reach for DEEs, differentiating them from EEs, which are characterized by spatial boundedness (Brown and Mason, 2017). Across geographical boundaries, DEEs act as a facilitating structure to consolidate a wide network of heterogeneous and geographically dispersed stakeholders as well as new ways of connecting entrepreneurs across borders (Nambisan et al., 2019b). Moreover, DEEs make collaboration with partners across industries possible while promoting new cross-sector entrepreneurial initiatives (ibid.). Organizational confines could also be surpassed as firms in the DEE act collectively with open, permeable boundaries (Cennamo et al., 2020). By extending entrepreneurial activities beyond organizational boundaries, DEEs incentivize digitally enabled interfirm collaborations (ibid).

4.3.7. Identification process

Lastly, the identity of a DEE is an important attribute which supports the governance mechanism as well as the interaction between the actors. By having an ecosystem identity, a DEE could acquire a system-level goal coupled by an intangible culture which supports cooperation (Du et al., 2018). Entrepreneurs could, however, maintain their own founder-based identity, which through longer relationships might develop into a shared identity (Bouncken and Kraus, 2022). Additionally, the DEE could assimilate the identity of the platform owner, with a set of rules, structures, and visions. Nevertheless, value co-creation could take place within an ecosystem with no fixed identity, where resources act as the foundation of actor exchanges (Siaw and Sarpong, 2021).

4.4. Typologies of digital entrepreneurial ecosystems

Drawing upon our DEE framework and the characteristics deduced from the literature, we developed a typology for DEEs that result from combining a set of characterizations relating to each ecosystem attribute. By juxtaposing two dimensions—the degree of autonomy in governance and the degree of collaboration within the ecosystem—a two-by-two typology showing four pure forms of DEE arises (see Fig. 7): the ‘Marketplace Ecosystem’, the ‘Innovation Platform Ecosystem’, the ‘Open-Source Ecosystem’, and the ‘Chat Room Ecosystem’. The typology does not suggest that there are only four kinds of DEEs but provides a range within which DEEs can be clustered.

The degree of autonomy with respect to governance mechanisms provides a basic structural pillar of a DEE affecting decision-making and power asymmetries (Cutolo and Kenney, 2021), relations and identification processes (Bouncken and Kraus, 2022), as well as the deployment of resources (Nambisan et al., 2019b). For instance, a high degree of autonomy incites collective interaction for decision-making and the coordination of activities by emergence (Elia et al., 2020). Low

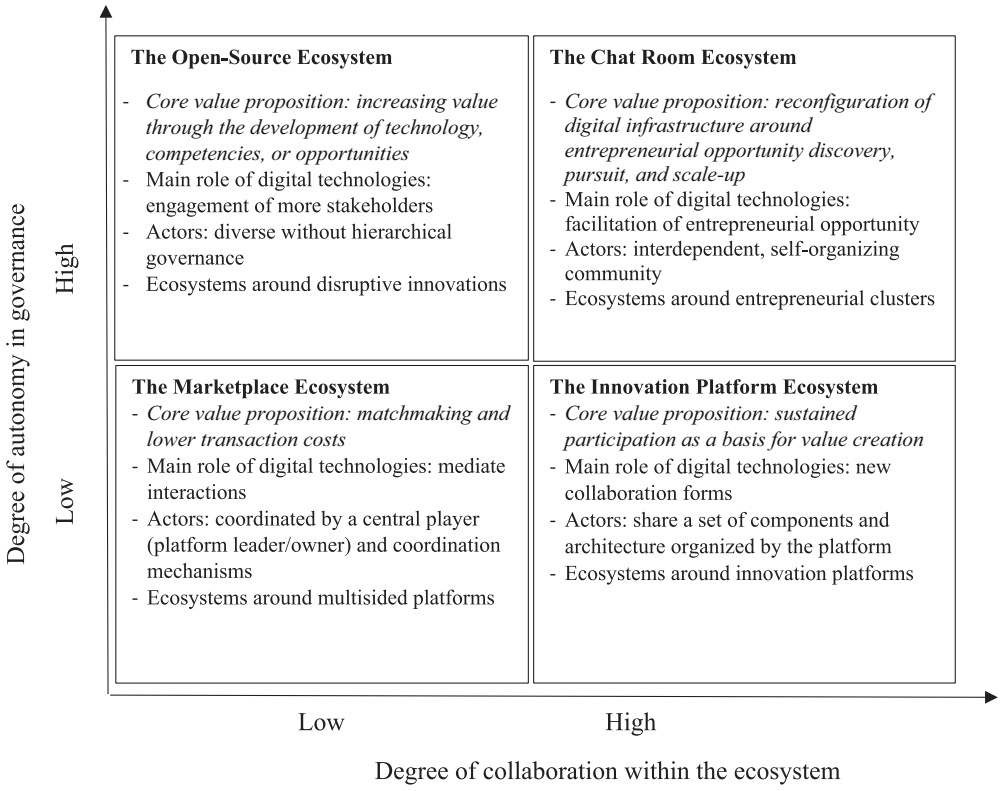

Fig. 7. DEE Typology.

autonomy, on the other hand, implies the existence of a central body (for example a platform owner) which facilitates value creation mechanisms and redistributes power (Hein et al., 2020). Furthermore, the degree of collaboration within a DEE provides a second pillar which determines the alignment among actors (Adner, 2017), the distribution of knowledge (Fan et al., 2021), and the outcome of value creation. A high degree of collaboration supports the creation of a collective output (Cennamo et al., 2020) and reinforces the co-specialization of actors (Nambisan et al., 2019b). A low degree of collaboration is related to a distributed network supported by ecosystem-level coordination which enables the integration of distributed efforts (Du et al., 2018).

First, upon the intersection of these two dimensions, we observe the 'Marketplace Ecosystem' with a low degree of collaboration and a low degree of autonomy. The platform owner organizes value creation by mediating between multiple actors. This is made possible through a digital architectural interface which facilitates interactions. As a result, matchmaker value (Sussan and Acs, 2017) is created, and transaction costs for users are reduced (Gawer, 2021). Such DEEs are present around multisided platforms with actors taking the roles of buyers or sellers. An example of 'The Marketplace Ecosystem' is the ecosystem around Airbnb. Airbnb enables entrepreneurs to connect and commercialize accommodation services (Sigala, 2018) while maintaining mechanisms that secure the authority and control of the core ecosystem components (Hein et al., 2018).

Second, we refer to the 'Innovation Platform Ecosystem' with a low degree of autonomy but a high degree of collaboration. The role of the governing entity in such DEEs is to encourage participation and engagement. Value is thus created through sustained mutuality between the actors. This is nevertheless supported by digital technologies which enable collaborating and accessing resources (e.g., through application programming interfaces and software development kits). These DEEs emerge around innovation platforms which encourage open innovation and build upon complementary products and services (Gawer, 2021). Google's Android ecosystem is an example of such a DEE. The innovation platform enables app developers to reach users and buyers (Hsieh and Wu, 2019). Meanwhile, the complementarities within the ecosystem help app developers maintain their performance (Kapoor and Agarwal, 2017).

Third, the 'Open-Source Ecosystem' emerges at the intersection of a low degree of collaboration and a high degree of autonomy. Ecosystem actors co-evolve around an innovation with the aim of increasing value through improved performance, effectiveness, or added offerings (Palmié et al., 2020). The engagement of more members, empowered by digital technologies, increases the legitimacy and competencies available in the ecosystem (ibid.). This DEE form is vital for disruptive innovations which require a strong support base and autonomous decision-making. For instance, GitHub hosts an open-source community of engaged actors by providing them with autonomy (Faridian, 2023), a decentralized control system, and transparency in coordination (Cosentino et al., 2017).

Fourth, the 'Chat Room Ecosystem' shows a high degree of collaboration and a high degree of autonomy. The actors in the ecosystem independently organize around entrepreneurial processes. With the support of digital technologies, entrepreneurial opportunities emerge, opening up prospects to create value collectively. These DEEs make use of digital structures to grow around entrepreneurial clusters. They cultivate cluster-level knowledge and redefine value creation processes (Autio et al., 2018). For example, Slack channels provide a purposeful infrastructure through which actors collaborate on specific projects, easily access information, and make decisions collectively.

It is important to note that for all four types of the DEE, we can see a reciprocal dependence of the DEE and the digital technology or digital platform. In other words, the DEE is both dependent on the platform and the platform depends on the DEE. For the 'Marketplace Ecosystem' and 'Innovation Platform Ecosystem', this dependence is very high as these ecosystems have a low degree of autonomy compared to the 'Open-Source Ecosystem' and the 'Chat Room Ecosystem'. Accordingly, by attracting contributors and interactions, the platform facilitates the formation of the digital ecosystem (Kenney and Zysman, 2016). Central to these interactions are the actors which include entrepreneurs, users,

and network participants.

4.5. Inclusive definition of digital entrepreneurial ecosystems

Our systematic literature review reveals that scholars attribute distinct features to DEEs, widening their conceptual ambiguity. For instance, Sussan and Acs (2017: 56) define DEEs as "the matching of digital customers (users and agents) on platforms in digital space through the creative use of digital ecosystem governance and business ecosystem management to create matchmaker value and social utility by reducing transactions cost". The authors focus on the interchange between users and agents and the matchmaker role of the ecosystem. Given our findings, this definition however covers only one possible form of DEE. Hence, the abovementioned definition lacks insight into ecosystems which organize around innovations, entrepreneurial opportunities, or sustained participation. Du et al. (2018: 1159) base their definition on Spigel (2017) and understand DEEs more broadly as "the combination of social, political, economic and cultural elements within a region that supports the development and growth of innovative start-ups pursuing new venture opportunities presented by digital technologies". Even though this definition embraces a wider lens, the role of digital technologies is reduced to generating opportunities, and therefore the difference between DEEs and traditional EEs remains blurry.

Another definition mentioned in the selected literature is from Elia et al. (2020: 5), considering a DEE to be "a self-organizing community of interdependent entrepreneurial agents able to capture (technology based) opportunities by leveraging the existence of a complex system of (digital) services and tools that enable actions and interactions throughout all the phases of the entrepreneurial process". The digital aspect is strongly highlighted in this definition, as is the encompassing entrepreneurial process. Nonetheless, based on the literature we have reviewed, actors in a DEE are not always self-organizing, and certain governing mechanisms are in some cases required to support entrepreneurial activities. Therefore, a more applicable definition is needed to provide more conceptual clarity and act as a base upon which to develop a coherent research field. We understand DEEs as complex and dynamic systems composed of heterogeneous actors that exploit digital technologies for value co-creation while relying on digital infrastructure that supports governance mechanisms, facilitates access to resources, enables the development of complementarities, and overcomes spatial boundaries. This definition highlights the centrality of digital technologies and the dynamic nature of interactions, as well as the ultimate entrepreneurial aim of creating value. By emphasizing that boundaries are challenged, the difference to EEs, which are regional in nature, is strengthened. We contend that this definition is broad enough to cover the different aspects of DEEs but distinct in emphasizing the peculiarity of the DEE concept with regards to other ecosystems or clusters.

5. Discussion and implications

Recognizing the need to consolidate the literature on DEEs and to provide a comprehensive understanding of the concept, we perform a systematic literature review exploring the intersection of digital entrepreneurship and EEs. Upon analyzing the literature, we acknowledge on the one hand that digital entrepreneurship is not an isolated phenomenon but rather takes place within an ecosystem and with the support of an infrastructure. On the other hand, we contend that the effect of digitalization on EEs results in changes in processes, interactions, and governing structures. The local implications are extended as the ecosystem acquires a wider reach. Hence, at the intersection of new collaboration forms and governance mechanisms, novel environments for entrepreneurship emerge. These DEEs provide fertile ground to support entrepreneurial actors and processes in the digital age. In addition to contributing to the literature on digital entrepreneurship and EEs, our study therefore advances research on the promising field of DEEs.

In line with the flexibility afforded by digitalization (Yoo et al., 2010), we acknowledge that there is no one-size-fits-all approach to DEEs. Our framework hence conceptualizes DEEs within an array of characterizations. Rather than having a set of conditions that should be met, the framework offers possibilities of how DEEs could take shape. This directs attention away from strict design limitations and toward the importance of the dynamics and attributes of ecosystems, such as the interrelations between actors, the use of complementarities, and the establishment of an identity. Practically, delineating the characterizations of DEEs enables designing policymaking approaches to reinforce these ecosystems which promote entrepreneurship.

Moreover, the fluidity of entrepreneurial processes and outcomes prompted by digitalization (Nambisan, 2017) implies that different DEEs cultivate different outcomes. While some authors have proposed that the performance of a DEE could be measured by the resulting unicorns (Acs et al., 2017) or digitally enabled unicorns (Torres and Godinho, 2022), our typology suggests various core value propositions which provide a measurement base for the performance of different DEEs. Because DEEs differ in terms of the degree of autonomy in governance and the degree of collaboration within the ecosystem, the management practices and strategies employed have to be adapted as well. Accordingly, the typology presented supports the development of targeted managerial implications. For instance, highly autonomous ecosystems require decentralized processes rather than a central mechanism. Furthermore, compared to ecosystems with low collaboration where participation is to be incentivized, the collective output in highly collaborative ecosystems is the locus of motivation.

While digital technologies have been considered on the one hand as the output of the ecosystem and on the other hand as the facilitating environment (Elia et al., 2020), we expand this perspective by asserting the role of digital technologies in affording new entrepreneurial possibilities, collaboration structures, means of participation, and mediation tools. This view increases the added value of DEEs. Additionally, the agility and connectedness that come with digitalization allows for new social and economic interactions (Abubakre et al., 2021). Considering that openness in entrepreneurship reinforces socioeconomic wellbeing (Nambisan et al., 2019a), this contribution can be translated to the ecosystem level. Using the ecosystem infrastructure as force multiplier and making use of the open and collaborative nature of DEEs, actors can cooperate on communal objectives such as sustainable development (George et al., 2021). DEEs could hence be a milieu for entrepreneurship to promote socioeconomic values and global goals.

Nevertheless, the DEE approach reconsiders the role of institutions and agency in entrepreneurship research (Sussan and Acs, 2017). The dynamics within an ecosystem and the infrastructure afforded by digital technologies create disruptions in governance structures and alter entrepreneurial processes. This implies that DEEs play a role in the wider economic and social context. Exploring the governance mechanisms in DEEs could accordingly provide insight into future, more effective structures for the digital economy (Acs et al., 2021).

6. Conclusion and future research directions

As research on DEEs is growing, definitional and conceptual clarity is needed to foster knowledge and keep pace with the advancement of the field. Our systematic literature review takes an important step in that direction. We explore the literature at the intersection of EEs and digital entrepreneurship. We identify that authors use different terms and explain the interplay of digitalization, entrepreneurship, and ecosystems from different perspectives, confirming that there is no common understanding of EEs in the digital context. Nevertheless, the various features assigned to the ecosystems discussed in the literature prompt our development of a conceptual framework with a comprehensive set of characteristics to describe DEEs. The framework presented includes a set of characterizations pertinent to ecosystem attributes of a DEE: governance, actors, resources, architecture, complementarity, reach, and

Table 1
Future research avenues exploring DEE attributes.

DEE attributes	Exemplary questions
Governance	- Which managerial practices are relevant in a DEE? - How is decision making influenced by different DEE governance structures? - How do governance structures affect DEE outcomes?
Actors	- How is power distributed among the different actors (e.g. users, entrepreneurs, etc.) in a DEE? - What roles and motivations do different actors have in a DEE? - How do the actors and the interactions between them affect the success of a DEE?
Resources	- How do the resources in a DEE support the development of individual entrepreneurial competencies? - What mechanisms ensure the access and distribution of resources among members of a DEE? - How can the relation between resources and outcomes be measured?
Architecture	- Which architecture favors a more effective development of DEEs and how can this be designed? - How can entrepreneurs deal with vulnerabilities that could arise from the openness or modularity of a DEE? - How does an open or modular architecture affect DEE outcomes?
Complementarity	- In what ways do the resulting complementarities extend the functionality of DEEs? - What approach can be used to trace the complementarities within a DEE? - How can the complementarities increase the value of a DEE?
Reach	- How do the open boundaries in a DEE shape the nature of collaboration and competition within the ecosystem? - How can the performance of a DEE be measured across (geographical/industry/firm) boundaries? - How can the outcomes of DEEs be scaled up across (geographical/industry/firm) boundaries?
Identification Process	- How do the different identification processes affect the formation of regulations, norms, and culture in a DEE? - In what ways is the identity of a DEE visible? - How are identification processes related to DEE performance?

identification process. Our approach acknowledges the dynamic nature of digitalization and the different features that DEEs have. The conceptual framework is extended by a two-by-two typology that delineates four forms of DEEs classified according to two dimensions: the degree of autonomy in governance and the degree of collaboration within the ecosystem. These dimensions serve as boundaries for a range of ecosystems which are depicted by the typology. By demonstrating the core value proposition, the main role of digital technologies, and the peculiarity of actors, our typology substantiates the types of DEEs presented. Derived from the review, our study offers a more applicable definition of a DEE which helps close the conceptual gap, providing a foundation for future research.

This research is not without limitations. The choice of keywords and our restriction of the selection to highly rated journals exclude parts of the literature which could offer additional insights. By limiting the review to the management literature, the study is not able to fully cover the interdisciplinary aspect of DEEs. Future research could apply different research methods and an interdisciplinary perspective to address this shortcoming. Moreover, empirical work that validates our framework and typologies is essential to increase the robustness of the concept. Based on the framework developed, we summarize in Table 1 specific research questions related to every DEE attribute. The questions highlight important future avenues of research and provide guidance for a growing research field. Beyond these investigations, future research could make use of our proposed definition as a base upon which to develop a coherent academic foundation regarding DEEs. Our study highlights the importance of DEEs in understanding entrepreneurship in the digital age and encourages the further exploration of this concept to advance knowledge on present-day ecosystems.

Declaration of competing interest

The authors have no relevant financial or non-financial interests to disclose. The authors further have no competing interests to declare that are relevant to the content of this article.

Data availability

Data will be made available on request.

Appendix 1. Articles included in the systematic literature review

Author (year)	Title	Journal	Research method	Allocated research stream	Investigated ecosystem attribute	Main findings
Acs et al. (2021)	The evolution of the global digital platform economy: 1971–2021	Small Business Economics	Conceptual	Interplay of Digitalization and Ecosystems	Governance- Actors-Architecture-Complementarity	- Digital platform economy (DPE) consists of three interrelated concepts: digital technology infrastructure, digital multisided platforms, and platform-based ecosystems - Startups play a crucial role in the evolution of the DPE
Amit and Han (2017)	Value creation through novel resource configurations in a digitally enabled world	Strategic Entrepreneurship Journal	Conceptual	Interplay of Digitalization and Ecosystems	Resources	- Business digitization calls for firms to adopt a system-based, value-creation-centric perspective - Digitization as an important contextual element for firms when conceiving of and designing their resource configurations
Ansari et al. (2016)	The disruptor's dilemma: TIVO and the U.S. television ecosystem	Strategic Management Journal	Empirical, qualitative	Interplay of Digitalization and Ecosystems	Actors	- Disruption may affect the entire ecosystem

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Author (year)	Title	Journal	Research method	Allocated research stream	Investigated ecosystem attribute	Main findings
						- Navigating coopetitive tensions requires continual adjustments in strategy
Autio et al. (2018)	Digital affordances, spatial affordances, and the genesis of entrepreneurial ecosystems	Strategic Entrepreneurship Journal	Conceptual	Based on EE Literature	Resources- Architecture- Reach	- The combination of digital and spatial affordances facilitates business model innovation for entrepreneurial opportunity discovery and pursuit - EEs as a distinct type of cluster that specializes in harnessing digital affordances and combines them with spatial affordances to support a distinctive cluster dynamic
Berné-Martínez et al. (2021)	A semantic analysis of crowdfunding in the digital press	Technological Forecasting and Social Change	Empirical, qualitative	Interplay of Digitalization and Ecosystems	Identification process	- Correspondence among social, academic and media patterns related to the crowd funding phenomenon - Crowdfunding platforms are relevant in the ecosystem and their specializations are important
Bouncken and Kraus (2022)	Entrepreneurial ecosystems in an interconnected world: emergence, governance and digitalization	Review of Managerial Science	Conceptual	Based on EE Literature	Governance- Complementarity- Identification process	- EEs occur in different forms, using different governance mechanisms, which are key to performance - The social relationships and relational governance of an EE triggers identification processes among the firms in the ecosystem toward an ecosystem meta-identity
Cennamo et al. (2020)	Managing digital transformation: Scope of transformation and modalities of value co-generation and delivery	California Management Review	Conceptual	Interplay of Digitalization and Ecosystems	Governance- Actors- Complementarity- Reach	- Digital transformation results in three different types of business model transformation: Data-Driven Processes, Ecosystems, and Platforms - Firms should consider the scope of the digital transformation along with the opportunities for value co-creation that the digital-enabled products and processes provide
Cutolo and Kenney (2021)	Platform-dependent entrepreneurs: Power asymmetries, risks, and strategies in the platform economy	Academy of Management Perspectives	Conceptual	Interplay of Digitalization and Ecosystems	Governance- Resources- Architecture	- Many tenets of traditional notions of entrepreneurship are no longer valid in situations where the entrepreneur depends upon a powerful online digital platform - Platform-dependent entrepreneurs have no control or little influence over the actions and strategies of platform owners
Denicolai and Previtali (2020)	Precision medicine: Implications for value chains and business models in life sciences	Technological Forecasting and Social Change	Empirical, qualitative	Interplay of Digitalization and Ecosystems	Resources	- Precision medicine is a multi-faceted phenomenon grounded on novel forms of innovation eco-systems and bundled-based models - A dramatic shift in the value chain, which is moving upstream from recovery and surgery to prevention and monitoring is revealed
Du et al. (2018)	From a marketplace of electronics to a digital entrepreneurial ecosystem (DEE): The emergence of a meta-organization in Zhongguancun, China	Information Systems Journal	Empirical, qualitative	Explicit DEE literature	Actors- Resources- Identification process	- The emergence of a DEE consists of three labor roles and two effort processes - A meta-organization captures an important characteristic of a DEE
Eckhardt et al. (2018)	Open innovation, information, and entrepreneurship within platform ecosystems	Strategic Entrepreneurship Journal	Empirical, quantitative	Interplay of Digitalization and Ecosystems	Architecture- Complementarity	- Specific information influences the perception of a complementor for opportunity discovery and engaging in entrepreneurship by commercializing a technology - Open innovation ecosystems foster the production of information that can stimulate subsequent entrepreneurship
Elia et al. (2020)	Digital entrepreneurship ecosystem: How digital technologies and collective intelligence are reshaping the entrepreneurial process	Technological Forecasting and Social Change	Conceptual	Explicit DEE literature	Governance - Actors	- Two complementary 'dimensions' of a digital entrepreneurship ecosystem: digital-output ecosystem and digital-environment ecosystem

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Author (year)	Title	Journal	Research method	Allocated research stream	Investigated ecosystem attribute	Main findings
Endres et al. (2022)	Digital innovation management for entrepreneurial ecosystems: services and functionalities as drivers of innovation management software adoption	Review of Managerial Science	Empirical, quantitative	Based on EE Literature	Complementarity	- Digital entrepreneurship ecosystem as a collective intelligence system - Innovation Management Software (IMS) adoption is considered to positively affect the new product development efficiency - Offering complementary consulting services together with IMS offerings to support the digitalization of innovation processes reduces the likelihood of IMS adoption
Fan et al. (2021)	Habitual entrepreneurship in digital platform ecosystems: A time-contingent model of learning from prior software project experiences	Journal of Business Venturing	Empirical, quantitative	Interplay of Digitalization and Ecosystems	Actors-Complementarity	- Time-contingent learning from prior app projects increases the feasibility for prevalent dynamic entrepreneurial ecosystems such as digital platforms - The resulting learning outcomes in highly dynamic entrepreneurial environments are weaker and more short-lived than learning benefits gained in more stable environments
Feldman and Lowe (2015)	Triangulating regional economies: Realizing the promise of digital data	Research Policy	Empirical, quantitative	Interplay of Digitalization and Ecosystems	Actors	- A time series data platform linking individuals, firms and institutions that is transferable to other regions - The existence of multiple entrepreneurial pathways that support new firm formation
Fink et al. (2020)	The ownership of digital infrastructure: Exploring the deployment of software libraries in a digital innovation cluster	Journal of Information Technology	Empirical, quantitative	Interplay of Digitalization and Ecosystems	Resources	- Cohabitation of community, proprietary, and big-tech infra-structural components - Libraries owned by different types of owners are able to cater to different needs of deploying companies
Frølund et al. (2018)	Developing successful strategic partnerships with universities	MIT Sloan management review	Conceptual	Interplay of Digitalization and Ecosystems	Governance	- Universities offer a wide and at times bewildering array of modes of engagement - Companies need to move from an ad hoc to a strategic approach to partnerships with universities
Garud et al. (2022)	Liminal movement by digital platform-based sharing economy ventures: The case of Uber Technologies	Strategic Management Journal	Conceptual	Interplay of Digitalization and Ecosystems	Governance-Resources	- The key to a venture's survival is liminal movement or the sequence of strategic moves that a platform-based sharing economy venture introduces its service and business model into an existing ecosystem - The urgency faced by the venture to generate network effects within a shifting window of opportunity changes the very nature and dynamics of its legitimacy-seeking efforts
George et al. (2021)	Digital sustainability and entrepreneurship: how digital innovations are helping tackle climate change and sustainable development	Entrepreneurship Theory and Practice	Conceptual	Interplay of Digitalization and Ecosystems	Actors	- Entrepreneurial actors employ digital technologies to tackle crucial sustainability challenge - Digital sustainability lens focuses on activities undertaken by entrepreneurial and incumbent firms that rely on digital innovations to create scalable socioecological value
Ghezzi (2019)	Digital startups and the adoption and implementation of lean startup approaches: Effectuation, bricolage and opportunity creation in practice	Technological Forecasting and Social Change	Empirical, mixed-methods	Interplay of Digitalization and Ecosystems	Resources	- Lean Startup Approaches (LSAs) are largely adopted in the sample of digital startups investigated, and digital entrepreneurs gain significant benefits from their implementation - LSAs are inserted into the entrepreneurship theory debate on effectuation, entrepreneurial bricolage and opportunity creation
Kramer et al. (2021)	Reaping the digital dividend? Sport marketing's move into esports: insights from Germany	European Journal of International Management	Empirical, qualitative	Interplay of Digitalization and Ecosystems	Identification process	- Esports as valuable for sport marketers, especially by leveraging digital marketing on an operational level

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Author (year)	Title	Journal	Research method	Allocated research stream	Investigated ecosystem attribute	Main findings
						- Esports as a field with great opportunity to reach a young target group in a constantly growing environment
Lorenzen (2019)	How early entrants impact cluster emergence: MNEs vs. local firms in the Bangalore digital creative industries	Management and Organization Review	Empirical, qualitative	Based on EE Literature	Governance	- MNE subsidiaries and local firms develop capabilities differently as early entrants to an emerging cluster - Local entrants, in particular, leverage international personal relationships for development of not only relational, but also production capabilities
Martin-Rojas et al. (2021)	Social media use and the challenge of complexity: Evidence from the technology sector	Journal of Business Research	Empirical, quantitative	Interplay of Digitalization and Ecosystems	Actors	- Social media is a valuable tool for facing increased complexity in current changing markets - Social media platforms support interactions and connectivity with a wide range of heterogeneous agents, enabling firms to capture important knowledge from them
Mas and Gómez (2021)	Social partners in the digital ecosystem: Will business organizations, trade unions and government organizations survive the digital revolution?	Technological Forecasting and Social Change	Empirical, quantitative	Interplay of Digitalization and Ecosystems	Actors	- Social partners (governments, business associations, and trade unions) have a clear but heterogeneous presence in digital media - There is no correlation between the HDI level and the digitalization of the analyzed social partners
Nambisan and Baron (2021)	On the costs of digital entrepreneurship: Role conflict, stress, and venture performance in digital platform-based ecosystems	Journal of Business Research	Empirical, quantitative	Interplay of Digitalization and Ecosystems	Architecture-Complementarity	- The stress generated by role conflict would reduce venture performance by interfering with entrepreneurs' performance of key tasks in digital ecosystems - The positive relationship between role conflict and stress is moderated by ecosystem openness and the negative relationship is moderated by entrepreneurs' self-control
Nambisan et al. (2018)	On open innovation, platforms, and entrepreneurship	Strategic Entrepreneurship Journal	Conceptual	Interplay of Digitalization and Ecosystems	Architecture-Complementarity	- Open innovation (OI) and platforms redefine the nature of partnerships and collaboration involved in entrepreneurial pursuits - Digital platforms and OI are changing the underlying risks and, thereby, transforming the social and economic processes of entrepreneurship
Nambisan et al. (2019b)	Global platforms and ecosystems: Implications for international business theories	Journal of International Business Studies	Conceptual	Interplay of Digitalization and Ecosystems	Governance-Resources-Architecture- Reach	- Digital platforms and ecosystems (DPEs) afford new ways of internationalization, facilitate new ways of building knowledge and relationships, and enable new ways of creating and delivering value to global customers - DPEs also imply varied types of costs and risks for MNEs and new firms
Palmié et al. (2020)	The evolution of the financial technology ecosystem: An introduction and agenda for future research on disruptive innovations in ecosystems	Technological Forecasting and Social Change	Empirical, qualitative	Interplay of Digitalization and Ecosystems	Actors	- Firms on the same broad technology and competence path benefit the whole system by developing and entering new niches - Technological advancement means more entrants in related technological categories, which is important for value creation in disruptive innovation systems.
Radziwon et al. (2022)	Ecosystem effectuation: creating new value through open innovation during a pandemic	R&D Management	Empirical, qualitative	Interplay of Digitalization and Ecosystems	Complementarity-Reach	- By recombining and repurposing the assets, reframing the scope of operational activities, and leveraging synergies among the ecosystem partners, companies could find a way forward to adapt to new realities - Open engagement with one's ecosystem can serve to identify and coordinate the allocation of

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Author (year)	Title	Journal	Research method	Allocated research stream	Investigated ecosystem attribute	Main findings
						financial resources, expertise, and capacity across private actors toward more valuable downstream uses.
Sahut et al. (2021)	The age of digital entrepreneurship	Small Business Economics	Conceptual	Interplay of Digitalization and Ecosystems	Complementarity	- Digital entrepreneurs create digital value by acquiring, processing, and distributing digital information - The new collaborative and social dynamics enabled by digital tools support knowledge sharing and facilitate opportunity recognition
Saiedi et al. (2021)	Global drivers of cryptocurrency infrastructure adoption	Small Business Economics	Empirical, quantitative	Interplay of Digitalization and Ecosystems	Architecture-Complementarity	- The adoption of cryptocurrency infrastructure is driven by perceived failings of traditional financial systems - Active support for Bitcoin is higher in locations with well-developed banking services
Schückes and Gutmann (2021)	Why do startups pursue initial coin offerings (ICOs)? The role of economic drivers and social identity on funding choice	Small Business Economics	Empirical, qualitative	Interplay of Digitalization and Ecosystems	Identification process	- The entrepreneur's social identity in conjunction with the enabling mechanisms of the blockchain technology shape entrepreneurial pursuits and funding choice - Funding, community building, tokenomics, and personal and ideological drivers impact the decision of entrepreneurs to fund their startup operations with ICOs
Secundo et al. (2020)	Digital academic entrepreneurship: A structured literature review and avenue for a research agenda	Technological Forecasting and Social Change	Conceptual	Interplay of Digitalization and Ecosystems	Actors	- Digital academic entrepreneurship engages more stakeholders for the identification of entrepreneurial opportunities and for the development of the entrepreneurial process in the university ecosystem - Digital technologies impact academic entrepreneurship by fostering entrepreneurial initiatives in university contexts
Siaw and Sarpong (2021)	Dynamic exchange capabilities for value co-creation in ecosystems	Journal of Business Research	Conceptual	Interplay of Digitalization and Ecosystems	Resources-Identification process	- Dynamic exchange capabilities can facilitate mutually beneficial exchanges between firms involved in value co-creation and co-capture in ecosystems - Relationship building capabilities are important antecedents to relational exchanges in ecosystems for value co-creation
Song (2019)	The digital entrepreneurial ecosystem—a critique and reconfiguration	Small Business Economics	Conceptual	Explicit DEE literature	Resources-Architecture- Reach	- Digital platforms as the core of the DEE that enable and facilitate entrepreneurship in the digital age - A sustainable DEE is one where user privacy is protected, third-party agents increase platform efficiency, platforms encourage competition, and digital infrastructure is secure
Song et al. (2022)	The digital transformation of a traditional market into an entrepreneurial ecosystem	Review of Managerial Science	Empirical, qualitative	Based on EE Literature	Actors- Architecture	- Transaction costs and marketing channel power might make physical wholesale markets less attractive for wholesalers and customers - Network effects and business model innovation can enhance the traditional wholesale advantages of physical markets, in turn transforming and upgrading this traditional ecosystem into an entrepreneurial one
Spulber (2019)	The economics of markets and platforms	Journal of Economics and Management Strategy	Conceptual	Interplay of Digitalization and Ecosystems	Architecture	- As digital technologies permeate the economy, it is not necessary to draw a distinction between markets and platforms - The study of platforms demonstrates the importance of participation and coordination in the formation of markets
			Conceptual		Actors- Architecture	

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Author (year)	Title	Journal	Research method	Allocated research stream	Investigated ecosystem attribute	Main findings
Sussan and Acs (2017)	The digital entrepreneurial ecosystem	Small Business Economics		Explicit DEE literature		- The DEE framework consists of four concepts: digital infrastructure governance, digital user citizenship, digital entrepreneurship, and digital marketplace - The integration of the digital ecosystem and the entrepreneurial ecosystem enables understanding the interactions of agents and users
Torres & Godinho (2022)	Levels of necessity of entrepreneurial ecosystems elements	Small Business Economics	Empirical, mixed methods	Explicit DEE literature	Resources	- All DEE elements are necessary to produce digitally-enabled unicorns, but for other outputs, only some DEE elements can be considered necessary - Digitally-enabled unicorns are a better measure of DEE performance rather than unicorns or new business creation
Tsatsou et al. (2010)	Towards a taxonomy for regulatory issues in a digital business ecosystem in the EU	Journal of Information Technology	Empirical, qualitative	Interplay of Digitalization and Ecosystems	Governance	- In order for digital business to develop among entrepreneurs in the EU and within different industry sectors and geographical locations, trust and regulation are of critical importance - A taxonomy that serves as the framework for a knowledge base of regulatory issues, leading to enhancing trust relationships in the digital business ecosystem
Ughetto et al. (2020)	Female entrepreneurship in the digital era	Small Business Economics	Conceptual	Interplay of Digitalization and Ecosystems	Architecture	- Advances in information and communication technologies are posited to provide unexpected and egalitarian opportunities for discriminated groups such as women when boundary conditions do not limit their impact - The centrality of digitalization in entrepreneurship implies the need to reconsider and revisit current policies targeted at supporting women-owned start-ups and growth-oriented businesses
Wagner (2021)	Startups in the supply chain ecosystem: an organizing framework and research opportunities	International Journal of Physical Distribution & Logistics Management	Conceptual	Interplay of Digitalization and Ecosystems	Actors	- Startups play significant roles in mobilizing and driving innovation in the supply chain ecosystem - The wider EE encompasses a number of additional actors that can be directly or indirectly involved in the incubation, acceleration or financing of startups in the supply chain ecosystem
Wallin and Fuglsang (2017)	Service innovations breaking institutionalized rules of health care	Journal of Service Management	Empirical, qualitative	Interplay of Digitalization and Ecosystems	Identification process	- Institutional sensemaking is an extremely important part of the innovation process - Legitimacy building is a crucial part of the institutionalization of innovation
Xiao et al. (2021)	Powered by "Qinghuai": The melding of traditional values and digital entrepreneurship in contemporary China	Information Systems Journal	Empirical, qualitative	Interplay of Digitalization and Ecosystems	Identification process	- Qinghuai as a concept is a product and reflection of the cultural and institutional complexity of contemporary China - Qinghuai facilitates digital entrepreneurship across the business, organizational, and technological domains
Yildirim and Tunçalp (2021)	A policy design framework on the roles of S&T universities in innovation ecosystems: integrating stakeholders' voices for industry 4.0	IEEE Transactions on Engineering Management	Empirical, qualitative	Interplay of Digitalization and Ecosystems	Actors	- Startup companies' cofounders highly value universities' roles in helping them solve critical challenges - A significant gap exists between what the Industry 4.0 startups expect and what universities could provide in Innovation ecosystems
Zeng et al. (2021)		Journal of Business Research	Empirical, qualitative		Resources- Reach	- Rather than focusing on internal resource management, sharing

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Author (year)	Title	Journal	Research method	Allocated research stream	Investigated ecosystem attribute	Main findings
	Sharing economy platform firms and their resource orchestration approaches			Interplay of Digitalization and Ecosystems		economy platform (SEPs) overwhelmingly pursue externally driven resource orchestration for value creation - Three main mechanisms by which SEPs firms orchestrate their external resources to create value and gain a competitive advantage

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