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Ecosystem types: A systematic review on boundaries and goals

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ABSTRACT

In the past few years, we have witnessed a reinvigorated interest by academics, practitioners and policymakers in the ecosystem concept. Recent reviews have set out to clarify the conceptual boundaries between ecosystem concepts. Yet there is still a lack of clarity when it comes to which ecosystem types can best help organisations achieve various goals. This systematic literature review advances our understanding of the conceptual boundaries between different ecosystems and, more importantly, identifies which types of ecosystems are suitable for achieving the goals. We focus on four commonly studied ecosystem types: business, innovation, entrepreneurship and knowledge ecosystems. The key findings centre on systematically demarcating the ecosystem types by accounting for (and distinguishing between) their conceptual boundaries and goals. The results show how multifaceted ecosystem goals are and reveal several shifts in the literature on ecosystem types over time. Our review establishes a thematic agenda for future research with practical outlook.

1. Introduction

Ecosystems have attracted increasing attention from management scholars over the past decade (Adner, 2017; Jacobides, Cennamo & Gawer, 2018; Shipilov & Gawer, 2020). Inspired by the concept of biological ecosystems, management scholars have studied ecosystems since the introduction of the business ecosystem by Moore (1993). Other types of ecosystems have subsequently been conceptualised, including the innovation ecosystem (Adner, 2006), the entrepreneurial ecosystem (Isenberg, 2010) and the knowledge ecosystem (Van der Borgh, Cloodt & Romme, 2012). Ecosystem research draws from a variety of literature, such as innovation studies, entrepreneurship research and the strategy literature, to understand ecosystems' unique dynamics and characteristics (Scaringella & Radziwon, 2018; Spigel and Harrison, 2017).

This proliferation of ecosystem research has resulted in a wide range of (re)definitions and related characteristics of the ecosystem concept (e.g. Adner, 2017; Jacobides et al., 2018). Research to date has covered ecosystems' value propositions (Jacobides et al. 2018, Kapoor 2018), their functional elements (Adner, 2017) as well as the similarities and differences between ecosystem types and related concepts (Scaringella & Radziwon, 2018; Shipilov & Gawer, 2020). Scholars have also attempted to understand the goals of different ecosystem types (Jacobides et al., 2018; Scaringella & Radziwon, 2018; Valkokari, 2015). An ecosystem goal can be defined as the constant (re)combination of artefacts, skills and ideas provided by ecosystem partners that results in a commonly created output based on the ecosystem's value proposition (Jacobides et al., 2018; Thomas & Autio, 2019; Valkokari, 2015). Nevertheless, the ecosystem type-specific attributes that contribute to the conceptual distinction between different ecosystems, from now on called boundaries, and the contribution of different ecosystems to the realisation of ecosystem-specific goals are still unclear (Han, Lowik & Weerd-Nederhof, 2017; Lamont & Molnár, 2002; Scaringella & Radziwon, 2018; Valkokari, 2015; Van Oosterhout, 2005). Scholars agree that the ecosystem literature in general suffers from a lack of consensus on the empirical scope, key theoretical features and theoretical roots that underpin our understanding of how ecosystems operate (Shipilov & Gawer, 2020; Suominen, Sepannen & Dedehayir, 2019; Thomas & Autio, 2019). In other words, ecosystem research suffers from conceptual proliferation (Durand, Grant & Madsen, 2016; Thomas & Autio, 2019). Therefore, several studies call for research into the applicability of the ecosystem concept in specific contexts (e.g. Gulati, Puranam & Thusman, 2012; Jacobides et al., 2018). Some of the same studies have already made advances in creating order in this conceptual proliferation, focusing on the precise conceptualisation of the goals of different ecosystems and their unit of analysis (the 'who' and 'what' that make up these ecosystems) (Scaringella & Radziwon, 2018; Thomas & Autio,

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2019).

Existing studies focus on (1) a single ecosystem type, (2) a single ecosystem goal (e.g. Thomas & Autio, 2019; Valkokari, 2015) and offer (3) narrative reviews (e.g. Thomas & Autio, 2019; Valkokari, 2015). To move forward, and to address the open questions raised above, the objective of this research is to use a systematic literature review to produce a rigorous conceptual clarity of the ecosystem literature. This study therefore aims to address three sequential research questions: (1) What are the conceptual boundaries of the ecosystem types? (2) What are the main ecosystem goals? (3) What future research is required to understand how ecosystem boundaries enable the achievement of ecosystem goals? Our study focuses on the business, innovation, knowledge and entrepreneurial ecosystems, as these are the most prevalent in the academic and business discussions on the topic (Scaringella & Radziwon, 2018). By providing an answer to these three research questions, we aim to identify theoretically illuminating similarities and differences between the four ecosystem concepts by looking into ways of how boundaries are drawn across contexts and types of ecosystems. This understanding could stimulate future research to create cross-fertilisation of insights while respecting the theoretical coherence in the literature on each ecosystem type.

We contribute to the advancement of the ecosystem literature by (1) building a common understanding of the conceptual boundaries of ecosystems, identifying and discussing not just one but four main types of ecosystems (Han et al., 2017; Shipilov & Gawer, 2020); (2) identifying and discussing how the ecosystem literature has developed over time, showing a shift from mere focal firm/single partner orientation towards a system-level orientation; (3) systematically demarcating ecosystem types by accounting for (and distinguishing between) their conceptual boundaries and ecosystem-specific goals (Scaringella & Radziwon, 2018; Thomas & Autio, 2019; Valkokari, 2015) and (4) proposing a research framework based on ecosystem boundaries and ecosystem goals that will constitute a conceptual base for identifying the future research agenda. We set out to define the key theoretical features of business ecosystems, innovation ecosystems, entrepreneurial ecosystems and knowledge ecosystems and more accurately to capture the goals of specific ecosystem types.

2. Ecosystems, ecosystem goals and ecosystem types

The ecosystem concept has become a popular way to depict collaboration across organisational boundaries (Kapoor, 2018; Moore, 1993). It can be defined as a multilateral structure of organisations that materialises a joint value proposition (Adner, 2017; Hannah & Eisenhardt, 2017; Jacobides et al., 2018; Kapoor, 2018). Ecosystems have two distinctive characteristics as compared to other collaborative concepts: complementarities and interdependencies are present at the same time, and the system is not fully hierarchically controlled (Jacobides et al., 2018; Kapoor, 2018).

Initially, ecosystem research focused on understanding the concept's distinctive and novel characteristics, rather than understanding how it relates to other concepts or other ecosystem types (Jacobides et al., 2018). Especially early research focused on describing the ecosystem phenomenon, partly to support practitioners to manage interdependencies (Hannah & Eisenhardt, 2017; Kapoor, 2018; Jacobides et al., 2018). Recent research attempts to develop definitions, explain how ecosystems emerge and identify how the ecosystem concept differs from and relates to other concepts (Aarikka-Stenroos & Ritala, 2017; Adner, 2017; Shipilov & Gawer, 2020). In other words, ecosystem research has previously focused on understanding what ecosystems are and how they operate, and only recently has the focus shifted towards understanding when ecosystems emerge and how ecosystems differ from other phenomena (Jacobides et al., 2018; Suominen et al., 2019).

In addition to understanding how ecosystems differ from other phenomena, scholars have also started to explore the goals of the different ecosystem types. In their definition of ecosystem-specific goals, scholars have mostly focused on defining a shared purpose for each ecosystem type, thereby focusing on one specific shared purpose per ecosystem type (e.g. Thomas & Autio, 2019; Valkokari, 2015). This shared baseline is often not defined as an actual output, but rather as an intention of what the ecosystem leader and/or partners aim to achieve. In addition, we observe that the coopetition element has not yet been integrated into most of the papers defining ecosystem-specific goals, though scholars recognise its importance (Hannah & Eisenhardt, 2017; Jacobides et al., 2018; Valkokari, 2015). Additionally, scholars focus on the power of an ecosystem leader in shaping the ecosystem type-specific goal and explain that the role of the leader is important in creating shared collective outputs (Jacobides et al., 2018; Ooms, Caniëls, Roijakkers & Cobben, 2020). Lastly, scholars have started to explore the diversity of ecosystem goals (Scaringella & Radziwon, 2018) by categorising them into several classes, such as goals aimed at creating economic advantages, innovation or a competitive position. Scholars have not yet reviewed how the definition of ecosystem-specific goals has changed over time, ignoring developments in the nature and focus of these goals in the ecosystem literature, such as the change from focusing only on technology performance towards social and sustainable value creation (e.g. Graca & Camarinha-Matos, 2017; Russel & Smorodinskaya, 2018).

Scholars started identifying and studying ecosystems when Moore (1993) introduced the business ecosystem. The literature has conceptualised several different types of ecosystems since then, including the innovation ecosystem (Adner, 2006), the entrepreneurial ecosystem (Isenberg, 2010) and the knowledge ecosystem (Van der Borgh et al., 2012). In the following, we briefly introduce these ecosystem types. The business ecosystem can be defined as a system in which "… *companies coevolve capabilities around a new innovation: they work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations*" (Moore, 1993, p. 76). Business ecosystems focus on a focal firm and its environment and describe how this firm can collaborate across industry borders (Jacobides et al., 2018; Moore, 1993). Business ecosystem research is centred on the relationships, partner selection, governance, evolution, structure and performance of a business ecosystem (Jacobides et al., 2018). The innovation ecosystem can be defined as "… *the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution*" (Adner, 2006, p. 2). The innovation ecosystem focuses on the development of innovations or the joint materialisation of a value proposition (Adner, 2006; Jacobides et al., 2018). Innovation ecosystem research centres on its emergence and evolution, governance, value propositions, relationships and business models (Suominen et al., 2019). Both the business and innovation ecosystems draw several parallels with the biology literature (Moore, 1993; Scaringella & Radziwon, 2018). While the business and innovation ecosystem types are mostly based on parallels with the biology literature, the knowledge and entrepreneurial ecosystems have their origins in the economic geography literature. The knowledge ecosystem can be defined as a "… *heterogeneous set of knowledge-intensive companies and other participants that depend on each other for their effectiveness and efficiency, and as such need to be located in close proximity*" (Van der Borgh et al., 2012, p. 151). The knowledge ecosystem focuses on knowledge interactions between actors to develop new knowledge (Jarvi, Almpanopoulou & Ritala, 2018). Knowledge ecosystem research centres on mechanisms for knowledge exchange, boundary spanning, business models and knowledge creation (Jacobides et al., 2018; Jarvi et al., 2018). The entrepreneurial ecosystem can be defined as "… *entrepreneurs [who] create new value, organized by a wide variety of governance modes, enabled and confined within a specific institutional context*" (Stam, 2015, p. 1764). The entrepreneurial ecosystem focuses on creating economic growth by stimulating entrepreneurship in different geographical scopes (Brem & Radziwon, 2017; Schaeffer & Matt, 2016). The entrepreneurial ecosystem research centres on entrepreneurship, geographical scale, institutions, economic growth, relationships and governance (Auerswald & Dani, 2017; Brem &

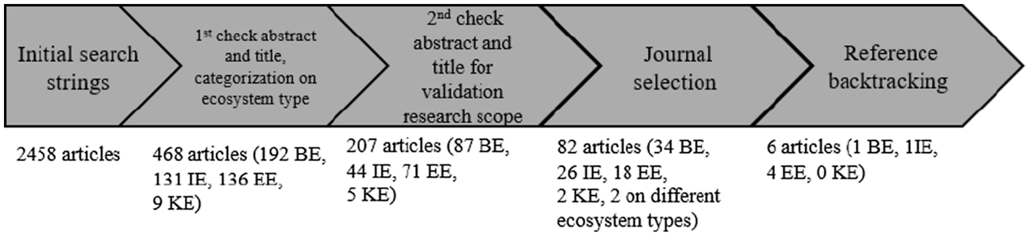

Fig. 1. Article number and selection.

Table 1
Inclusion criteria.

Inclusion	Reasons
Studies focusing on business ecosystems, innovation ecosystems, entrepreneurial ecosystems, knowledge ecosystems	Focus on the key ecosystem types
Peer-reviewed journals	To only find 'reliable' knowledge (Tranfield, 2003)
Document types	Articles, reviews
Timespan	1993–2018 (both years inclusive)
Search category	Management, business, economics, engineering industrial (Chesbrough, Vanhaverbeke & West, 2014)
Exclusion	
Ecosystem services	Focus on cultural aspects of regions
Biological ecosystems	Focus on biological ecosystems or ecological aspects
Non-English literature	No resources for proper translation

Radziwon, 2017; Spigel, 2015).

3. Methodology

This study adopts a systematic literature review research design to identify peer-reviewed studies on the four selected ecosystem types, which fully cover the diversity of the ecosystem landscape. This research design allows us to systematically examine the quality, methods and contents of these studies as well as to identify all relevant underlying theoretical elements (Armitage & Keeble-Allen, 2008; Tranfield, Denyer & Smart, 2003). Our method is in line with the approach used by other reviewers in the field, such as Spender, Corvello, Grimaldi & Rippa (2017) and Scaringella & Radziwon (2018).

When deciding upon the ecosystem types to focus on, we reviewed the literature to understand which ecosystem types were identified as relevant by other scholars. Several studies have compared or identified ecosystem types by (systematically) reviewing the literature (e.g. Aarikka-Stenroos & Ritala, 2017; Dedehayir, Makinen & Orrt, 2018; Han et al., 2017; Jacobides et al., 2018; Scaringella & Radziwon, 2018; Valkokari, 2015). Dedehayir et al. (2018) and Valkokari (2015) focus on business, innovation and knowledge ecosystems; Jacobides et al. (2018) and Han et al. (2017) examine business and innovation ecosystems. Dedehayir et al. (2018) and Jacobides et al. (2018) also consider the platform ecosystem in their analysis. Aarikka-Stenroos & Ritala (2017) focus on business, innovation, entrepreneurial, platform and service ecosystems, while Scaringella & Radziwon (2018) examine innovation, knowledge, entrepreneurial and business ecosystems. All of these studies show the relevance of considering the business and innovation ecosystem types, because all six studies include both ecosystem types in their analysis. The knowledge ecosystem was part of three of the aforementioned studies, whereas the platform and entrepreneurial ecosystem were included in two of the studies. Despite the limited focus on the entrepreneurial ecosystem type in the literature, the number of publications on entrepreneurial ecosystems have increased, especially since 2015. We therefore included this ecosystem type in our analysis. In addition to the ecosystem types identified above, scholars have increasingly started to study digital ecosystems (e.g. Cusumano, Gawer & Yoffie, 2019), but this ecosystem type has mostly been treated as a subtype of business ecosystems (e.g. Dedehayir et al., 2018; Valkokari, 2015). Considering the digital and the platform ecosystem types, we have therefore also integrated the digital and platform ecosystems in our review, albeit as a subtype of an innovation ecosystem. That is, to maintain focus on the broad range of ecosystem types, we do not specifically elaborate on these as standalone concepts (cf. Dedehayir et al. 2018; Scaringella & Radziwon, 2018; Valkokari 2015). Given the focus of previous reviews and the growth in research publications, we decided to focus on the business, innovation, entrepreneurial and knowledge ecosystem types in this study.

3.1. Data sources, data collection, data selection and data categorisation

We used a five-stage strategy to look for and select the articles included in our systematic review. Fig. 1 provides an overview of the number of articles per stage.

First, we identified appropriate journal articles. The selected keywords were identified by looking at keywords from previous studies in the field (e.g. Dedehayir, Makinen & Orrt, 2018; Han et al., 2017; Tsujimoto, Kajikawa, Tomita & Matsumoto, 2018). Subsequently, these were extended with the results of the initial literature assessment. Initially, keywords such as 'ecosystem', 'network', 'platform', 'business', 'knowledge', 'knowledge-based', 'innovation', 'innovative', 'entrepreneurship', 'entrepreneurial' and 'orchestration' were identified, resulting in 18 search queries (see Appendix A for search strings and the total number of articles). In line with other systematic research reviews (e.g. Usman, Roijakkers, Vanhaverbeke & Frattini, 2018), we performed several preliminary searches on Google Scholar using the basic search strings to identify additional keywords. We identified the additional keywords 'system' and 'actor', resulting in three additional search strings.

We then entered each search string into Web of Science (WoS) to identify the key citation indexes for review. WoS was identified as the most appropriate database for this research, as it is known for including high-quality journal articles, has a high coverage on management-related topics and is able to retrieve older sources (Ball & Tunger, 2006; Hicks & Wang, 2010). We focused our search on the following search categories: 'management', 'business', 'economics' and 'engineering industrial' (Chesbrough, Vanhaverbeke & West, 2014). The combination of these search categories aimed at excluding 'environmental sciences' and 'computer sciences', as articles in these categories were found to discuss ecosystems of a non-business nature.

Second, the collected articles (2458 in total) were checked for duplicates, after which the title and abstract of each article were reviewed twice based on the inclusion and exclusion criteria (see Table 1) as well as the research scope. The articles were also categorised by ecosystem type. By reading the title and abstract of each article, we analysed which ecosystem type the articles focused on. In case of doubt, we read the entire article to create a better understanding of the ecosystem type on which the article was built. We found that the selected articles were based on other literature streams and other literature on ecosystem

Table 2
Coding scheme.

Conceptual aspects	Coding scheme
Boundary	· *Competitive advantage*: how a specific ecosystem can outperform other ecosystems and/or individual companies (Porter, 1985; Valkokari, 2015) · *Geographical scope*: borders set up for the ecosystem in terms of geographic or digital scope (e.g. local, regional, national, global) to access resources needed for the system to thrive (Scaringella & Radziwon, 2018; Valkokari, 2015) · *Ecosystem development:* dynamic evolution over time, phases to describe the evolution (Clarysse et al., 2014; Valkokari, 2015) · *Orchestration:* characteristics and nature of the initiating and/or facilitating organisation, who takes a leading role in the ecosystem (Shipilov & Gawer, 2020; Valkokari, 2015) · *Stakeholders:* unique set of direct and indirect actors contributing to and/or participating in the ecosystem having a relation with the ecosystem (Valkokari, 2015) · *Structure*: set-up or construction of relationships, interactions, structures, processes etc. between interacting stakeholders aiming to realise the ecosystem function (Valkokari, 2015) · *Value creation and capture mechanisms*: mechanisms used to (co-)create and capture value for the individual organisations and/or the ecosystem to realise individual and/or ecosystem value proposition(s) (Valkokari, 2015)
Ecosystem goal	· *Goal:* the constant (re)combination of artefacts, skills and ideas by ecosystem partners that results in a commonly created output based on the ecosystem's value proposition (Jacobides et al., 2018; Valkokari, 2015)

types, and as a result, some articles had to be discussed by the full author team to decide their categorisation of ecosystem type. Some articles focusing on several ecosystem types were classified into different ecosystem type categories. When reading the abstracts, articles that presumably focused on ecosystem services or biological ecosystems were also read through to decide whether they should be included or excluded based on their focus. The reason for this is that in some cases the articles examined ecosystem services and biological ecosystem literature to explain phenomena within the four ecosystem types covered by our review. All articles were reviewed by two authors and assessed according to the inclusion criteria (see Table 1).

Subsequently and according to reputable reviews in the field, e.g. Jacobides et al. (2018), Tsujimoto et al. (2018) as well as Shipilov & Gawer (2020), three international journal quality rankings (FT 50 (American), ABDC (Australian) and ABS (British)) were used to develop a list of A and A + journals to select a final sample of articles for the content analysis. More specifically, to implement this selection, we developed the A and A + journals as identified by the quality rankings, added them to a list and checked for duplicates. We then used this list to select the articles published in the selected journals from the original set of articles. As a result, 85 articles were selected and included in the systematic literature review: 34 business ecosystem articles, 26 innovation ecosystem articles, 18 entrepreneurial ecosystem articles, two knowledge ecosystem articles and two articles focusing on several ecosystem types and identifying the differences between them (Clarysse, Wright, Bruneel & Mahajan, 2014; Scaringella & Radziwon, 2018). Finally, reference backtracking was used to identify missing articles, resulting in an additional business ecosystem article, an innovation ecosystem article and four entrepreneurial ecosystem articles (also see Fig. 1 for article number and selection). These articles were relevant for the analysis of the review sample of several ecosystem types, resulting in a total number of 88 articles selected for analysis. A list including the article title, year of publication, author(s) and journal can be found in Appendix B. The articles along with the inclusion criteria were entirely read by the authors, and for each article, a report structure was identified. This structure aimed to collect general information for each article in terms of methodology, research design, scope and nature (see Appendix C for an overview of the journal articles). Following our screening process, we included 88 articles published between 1993 and 2018.

3.2. Content analysis and validity procedures

The content analysis identified key themes, conceptual boundaries and applications of the different ecosystem types. As a starting point, we composed an initial list of codes derived from the ecosystem literature. Several scholars have attempted to explain the differences between ecosystem types, focusing on their different characteristics. When comparing ecosystem types, scholars define boundaries that enable them to identify the different ecosystem constructs based on differences in characteristics (e.g. Han et al., 2017; Scaringella & Radziwon, 2018; Thomas & Autio, 2019; Valkokari, 2015). Furthermore, several scholars have differentiated between the goals of the different ecosystem types (Scaringella & Radziwon, 2018; Thomas & Autio, 2019; Valkokari, 2015). The list of boundaries and goals based on the literature has been used to code ten randomly selected journal articles out of the total set of selected articles. Based on the content analysis of these articles, the initial list of codes was adapted to better accommodate emerging themes in these selected articles. We used the resulting list of codes to conduct the content analysis of all the articles. During the analysis process, emergent axial coding was used to relate the data, reveal codes and subcategories as well as construct linkages between the articles. The coding procedures and content analysis were performed using the MaxQDA software package for qualitative data analysis. The coding scheme used for the content analysis can be found in Table 2.

Several procedures were implemented to safeguard the validity of our research results. First, we started with a list of broad keywords to build our search queries. We ran several pilot searches to analyse whether the retrieved articles were within the research scope and to identify additional keywords. We also kept record logs, including details such as the full search history, search data, article elimination reasons and the name of the searcher (Gough, Oliver & Thomas, 2017). Furthermore, we piloted our analytical procedures by using a sample of ten randomly selected journal articles from the total set of selected articles to test the coding structure and to confirm whether our approach was able to capture all relevant information on boundaries and ecosystem goals from the selected articles. During the publication selection and content analysis, several researchers went through the journal database to achieve research triangulation. Part of this process was to develop independent analyses of the method and the selections of articles to test our approaches. The classification schemes were mostly based on earlier systematic literature reviews aimed at identifying the differences between ecosystem types. To test for citation bias, the articles identified by reference backtracking were also controlled so that the global quality journal list only included high-quality articles (Gough et al., 2017).

4. Findings

In this section, we will integrate the selected literature on ecosystems and analyse it using the boundary lens to provide a richer understanding of which ecosystems best enable the realisation of specific goals as well as to develop a better understanding of the boundaries that can be recognised between the ecosystem types.

4.1. The boundaries of ecosystem types

Scholars have used different terms to identify the conceptual boundaries, such as the conceptual boundary, invariant and characteristic (e.g. Aarikka-Stenroos & Ritala, 2017; Scaringella & Radziwon, 2018). Investigating the boundaries of the four ecosystem types offers the opportunity to identify the similarities and differences between the constructs, thereby organising the knowledge produced so far. In our

Table 3
Ecosystem type boundary condition overview.

Ecosystem type/ characteristic	Business	Innovation	Knowledge	Entrepreneurial
Competitive advantage	Focal firm focus	Ecosystem and partner focus	Ecosystem and partner focus	Ecosystem focus
Geographical scope	Combination global and local, local, global	Combination global and local, local, national	Geographical co-location	Local, regional, national
Temporal scope	Evolutionary focus	Evolutionary focus	Evolutionary focus	Evolutionary focus
Orchestration	Focal firm	Focal firm	No focal firm	No focal firm
Actors	Based on roles or partner types	Based on roles or partner types	Based on partner types	Based on partner types
Structure	Platform, network	Platform, network, cluster, alliance	Prefigurative form, partial form	Cluster, platform
Value creation and capture	Emphasis on value capture partner level	At ecosystem and partner level	At ecosystem and partner level	Emphasis on value creation ecosystem level

research context, a boundary can be defined as an ecosystem type-specific attribute that contributes to the conceptual distinction between different ecosystem types. These boundaries thus provide information on ecosystem type-specific attributes that make up the concepts (Scaringella & Radziwon, 2018; Valkokari, 2015; Van Oosterhout, 2005). Boundaries are therefore suitable for conducting a comparative analysis of ecosystem types by illuminating the similarities and differences, looking into ways in which boundaries could be drawn across contexts and types of ecosystems (Gulati et al., 2012; Lamont & Molnár, 2002; Valkokari, 2015). Each ecosystem is characterised by a unique combination of boundaries that enable them to realise the goals of the ecosystem types (Valkokari, 2015). In the next section, we discuss seven boundaries that we could identify in our analysis. An overview of the boundary conditions can be found in Table 3.

4.1.1. Boundary 1: Source of competitive advantage

In the ecosystem research context, the concept of competitive advantage has a slightly different meaning than the traditional definition of Porter's competitive advantage. Originally, it referred to the ability of a firm to perform better than others did in the same market or industry. Ecosystems can span several industries and markets (Moore, 1993), and, therefore, the competitive advantage of an ecosystem explains how a specific ecosystem can outperform other ecosystems and/or individual companies.

Scholars identify different sources of the competitive advantages for the four ecosystem types. The source of the competitive advantage of the innovation and knowledge ecosystems is mostly relational, meaning that the competitive advantage is a result of the interdependencies between ecosystem partners (Dyer & Singh, 1998). The source of the competitive advantage of the business and entrepreneurial ecosystems is structural, meaning that the competitive advantage is a result of the structural setup/design of the ecosystem. In addition to the differences in sources, we find a difference in terms of for whom the competitive advantage is created. In the context of business and innovation ecosystems, the competitive advantage is most often achieved for a single partner, whereas the entrepreneurial and knowledge ecosystems focus on creating competitive advantages at the ecosystem level for all partners.

Shared technology platforms are a prime example from the literature of a structural source of a competitive advantage that we identify in the business ecosystem literature. The use of platforms results in advantages such as shared communication structures (Liu & Rong, 2015; Makinen, Kanniainen & Peltola, 2014), technology standardisation (Li, 2009), economies of scale (Clarysse et al., 2014; Iansiti & Levien, 2004), next-level product innovation processes (Stead & Stead, 2013) as well as technological performance improvements and management (Dedehayir & Makinen, 2011). The innovation ecosystem literature has identified interdependencies between various market actors as the source of competitive advantage (Adner & Kapoor, 2010; Russel & Smorodinskaya, 2018; Shaw & Allen, 2018). In business and innovation ecosystems, the competitive advantage is affected by the ability of an orchestrator to monitor and react to internal and external changes, which in turn influence its dynamic capabilities (Jacobides et al., 2018; Teece, 2017). Focus is often on creating a competitive advantage for the orchestrator and in some cases for ecosystem partners, resulting in a single partner orientation in both pieces of literature. The knowledge ecosystem has identified network externalities at both ecosystem and partner level as the source for creating a competitive advantage. Such network externalities can result in advantages like shared knowledge generation (Clarysse et al., 2014; Jarvi et al., 2018; Van der Borgh et al., 2012). The entrepreneurial ecosystem has the ecosystem's geographical structure as a source of competitive advantage. The geographical structure enables entrepreneurial ecosystems to generate positive externalities or agglomeration effects (Brown & Mason, 2017; Bruns, Bosma, Sanders & Schramm, 2017; Sussan & Acs, 2017). The competitive advantage of an entrepreneurial ecosystem thus takes a geographical approach by focusing on generating effects on a local, regional or even national scale, thereby not directly creating a competitive advantage for its partner organisations.

4.1.2. Boundary 2: Geographical scope

The geographical scope has turned out to be essential in all four ecosystem types, because resource access is important for an ecosystem to achieve its goals. The business and innovation ecosystem literature explains that local specialised knowledge should be complemented with global market knowledge and expertise (Dedehayir et al., 2018; Holgersson, Granstrand & Bogers, 2018; Khavul & Bruton, 2013). Beyond the reasons of resource access, the regional and national geographical scope of these ecosystems is also important, because it is at this level that governments can provide the required institutional, regulatory framework for innovations to emerge (Pombo-Juarez, Könnölä, Miles, et al., 2017; Shaw & Allen, 2018; Xu, Wu, Minshall & Zhou, 2018).

In the knowledge and entrepreneurial ecosystems, a call exists for the geographical co-location of partners. The knowledge ecosystem literature describes the geographical co-location of partners in places dubbed 'parks', 'campuses' or 'technology hotspots' (Clarysse et al., 2014; Jarvi et al., 2018; Van der Borgh et al., 2012). Therefore, geographical proximity is key to this ecosystem type, as it is assumed to enable interaction with local universities and research organisations (Clarysse et al., 2014; Jarvi et al., 2018; Van der Borgh et al., 2012). Despite the focus on geographically close partners, the knowledge generated within the knowledge ecosystem can still flow beyond a specific geographical area. This is seen, for example, at the High Tech Campus Eindhoven, the Netherlands, where several multinationals are situated, disseminating their own locally generated knowledge globally via their firms (Jarvi et al., 2018; Van der Borgh et al., 2012). The entrepreneurial ecosystem literature focuses on locally or regionally based ecosystems (Clarysse et al., 2014; Spigel, 2015; Spigel & Harrison, 2017). Within these ecosystems, geographical proximity is believed to be important to stimulate relationship development, network formation and to create the conditions for co-learning and experimentation (Brown & Mason, 2017; Motoyama and Knowlton, 2016; Schaeffer & Matt, 2016). Geographical proximity then enables the development of a vibrant, stimulating environment for entrepreneurship, such as in Strasbourg, France (Schaeffer & Matt, 2016) or in St. Louis, USA (Motoyama and Knowlton, 2016), where vibrant ecosystems for entrepreneurs and start-ups could develop over time.

4.1.3. Boundary 3: Ecosystem development

The development of ecosystems over time has only been discussed for three out of the four ecosystem types. In the business and innovation ecosystem literature, it has been researched extensively (e.g. Kapoor & Argwal, 2017; Makinen et al., 2014; Moore, 1993). More recently, the entrepreneurial ecosystem literature has also started to explore the ecosystem evolution (Auerswald & Dani, 2017; Kuratko, Fisher, Bloodgood & Hornsby, 2017; Mack & Mayer, 2016; Schaeffer & Matt, 2016), whereas earlier studies were exploratory and took a static perspective of the entrepreneurial ecosystem (Brown & Mason, 2017; Neck, Meyer, Cohen & Corbett, 2004). For example, Auerswald and Dani (2017) studied the dynamics over time of a local biotechnology-related entrepreneurial ecosystem, in which they mapped a set of indicators for ecosystem vitality. Despite the claim that knowledge generation requires a long-term focus (Clarysse et al., 2014; Jarvi et al., 2018; Van der Borgh et al., 2012), the knowledge ecosystem literature has not yet examined the development of ecosystems over time.

Irrespective of the type of ecosystems studied, it appears that the phases as defined by Moore (1993), i.e. birth, expansion, leadership and self-renewal, are dominant in the literature when scholars examine ecosystem development. Most studies use the development phases of Moore (1993), rename these phases or add additional phases (e.g. Kapoor & Argwal, 2017). Studies focusing on ecosystem development have documented how the ecosystem's internal structure, actors, culture, etc. evolve (Kapoor & Argwal, 2017; Makinen et al., 2014; Moore, 1993).

4.1.4. Boundary 4: Orchestration

Ecosystems are often led by an orchestrator who uses governance mechanisms to align partners, prevent opportunistic behaviour, realise the joint value proposition, etc. (Ritala, Agouridas, Assimakopoulous and Gies, 2013). A recent study also argues that there are differences across the literature in 'who', 'what' and 'how' an ecosystem is led (Shipilov & Gawer, 2020) – an observation that also follows from the present literature review. The business and innovation ecosystem literature attributes a leading, almost directive role to an orchestrator who is usually a firm. Knowledge and entrepreneurial ecosystems are often a university, research organisation, government or an independent management organisation in a leading but relatively more facilitating and supporting role.

In the business ecosystem literature, a 'large' firm (e.g. Microsoft, Google, Cisco or Walmart) is often identified as the orchestrator of the ecosystem (Clarysse et al., 2014; Iansiti & Levien, 2004; Kapoor & Argwal, 2017). These large firms often have a lot of power within the ecosystem; one could say that they set the rules for participation and determine or provide for the shared technical infrastructure (Clarysse et al., 2014; Iansiti & Levien, 2004; Moore, 1993). Whereas the business ecosystem orchestrator mostly aims at providing benefits for its own sake, the innovation ecosystem orchestrator acts out of more than mere self-interest. Here, the orchestrator manages the central resources, co-envisions and co-manages the ecosystem evolution, aligns partner interests and distributes the value over all partners (Adner, 2006; Leten, Vanhaverbeke, Roijakkers, Clérix & Van Helleputte, 2013; Ritala et al., 2013). The innovation ecosystem orchestrator aims to create both value for its own organisation as well as value for the ecosystem and its partners (Leten et al., 2013).

In the knowledge ecosystem literature, the orchestrator is often an independent management team, a research organisation or a university supporting and facilitating the ecosystem's innovation processes (Clarysse et al., 2014; Jarvi et al., 2018; Van der Borgh et al., 2012). A government (Carayannis, Grigoroudis, Campbell, Meissner & Stamati, 2017; Isenberg, 2010; Motoyama and Knowlton, 2016) or university/research organisation leads the entrepreneurial ecosystem (Miller & Acs, 2017; Schaeffer & Matt, 2016; Thompson, Purdy & Ventresca, 2018). Here, the orchestrator is responsible for creating and facilitating the required preconditions for new venture creation (Isenberg, 2010; Spigel, 2015; Spigel & Harrison, 2017). One example is the entrepreneurial ecosystem around the University of Strasbourg, France, where the university's Technology Transfer Office stimulated academic entrepreneurship in an emerging ecosystem. The university became the hub organisation when the entrepreneurial ecosystem started to grow – by both building and orchestrating the network of ecosystem partners (Schaeffer & Matt, 2016).

4.1.5. Boundary 5: actors and their roles

Each ecosystem consists of a group of actors collaborating to achieve the ecosystem goal. These actors can be perceived as internal stakeholders in the ecosystem. This is because they are part of the system and therefore have a stake or interest in it. Looking at actors in ecosystems from the stakeholder perspective, recent literature points out that interactions at the micro level (the behaviour of the ecosystem's individual stakeholders) affect macro-level interactions (the goal realisation of the ecosystem) (Linder & Foss, 2018; Philips & Ritala, 2019). Not surprisingly, therefore, our analyses also identify 'actors and their roles' as a conceptual boundary. In the ecosystem literature, actors are mostly categorised based on roles or member organisation type.

In business ecosystems, actors are categorised based on their roles (Dedehayir et al., 2018; Iansiti & Levien, 2004; Moore, 1993) or member organisation type (Battistella, Colucci, De Toni & Nonino, 2013; El Sawy, Amsinck, Kraemmergaard & Lerbech Vinther, 2016; Li, 2009). Most studies build upon the roles as defined by Iansiti & Levien (2004): keystone, niche player and the dominator (Kapoor & Argwal, 2017; Makinen et al., 2014; Tellier, 2017). In terms of the organisation type, studies mostly identify private firms and users as actors in the business ecosystem. An example of a business ecosystem in which the partners are categorised in terms of roles can be found in the automotive sector in California, USA, which discusses the influence of the orchestrator's choices on niche market complementors (Pierce, 2009). The innovation ecosystem literature also categorises actors both in terms of roles (Dedehayir et al., 2018; Holgersson et al., 2018) and partner types (Adner, 2006; Kwak, Kim & Park, 2018; Leten et al., 2013). In a way, it is therefore similar to the business ecosystem, but the innovation ecosystem focuses on a more diverse set of actors, including governments, universities and research organisations in addition to the aforementioned types of actors. An example of such a diverse innovation ecosystem is that of a healthcare smartphone app in the United Kingdom. In this (digital) ecosystem, firms from a variety of industries, governmental organisations, students and interests groups participated to make the ecosystem happen (Shaw & Allen, 2018).

The knowledge and entrepreneurial ecosystem literature are mainly influenced by the economic geography literature and therefore have a distinct approach to actor categorisation (Scaringella & Radziwon, 2018). These ecosystem types consider different partner types (Clarysse et al., 2014; Jarvi et al., 2018; Stam, 2015; Van der Borgh et al., 2012). In both the knowledge and entrepreneurial ecosystem literature, a more diverse set of indirect actors is included as compared to the business and innovation ecosystems. These ecosystems may include governmental organisations from different levels, venture capitalists and investors to name a few examples. At the High Tech Campus Eindhoven, the Netherlands, a variety of high-tech companies are collaborating with local and regional governmental organisations, venture capitalists, knowledge institutions, universities and an independent orchestrator to maintain a campus that facilitates joint knowledge creation and innovation production (Van der Borgh et al., 2012).

4.1.6. Boundary 6: Structure

Each ecosystem type is based on specific structures that are tightly

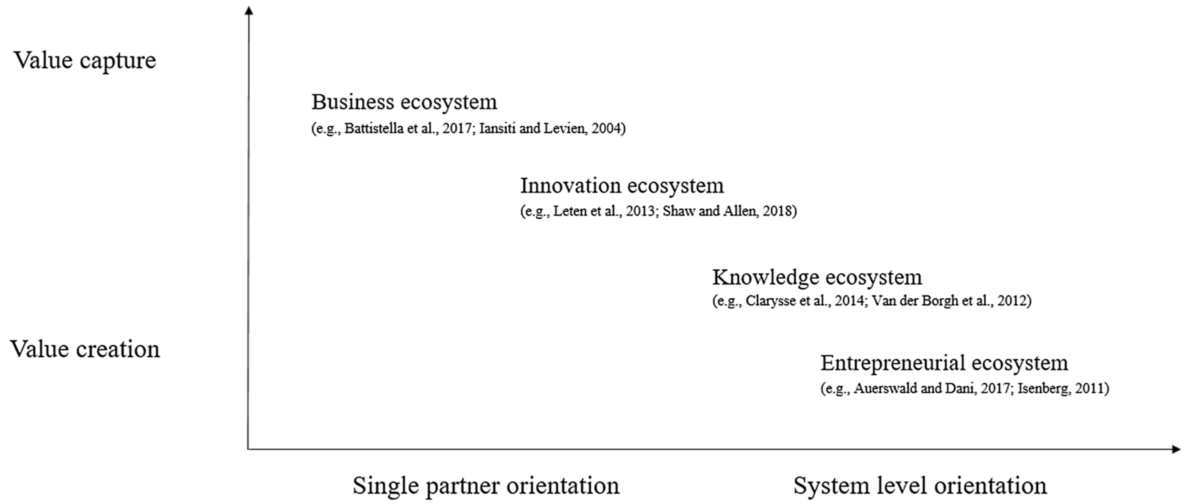

Fig. 2. Ecosystem focus on value creation and capture.

linked to the ecosystems goals, which we proceed to discuss in the next section. When looking at the specific structures, business and innovation ecosystems are mostly built on a platform structure (creating network effects) and entrepreneurial ecosystems on a cluster structure (stimulating entrepreneurship). The literature provides no information about the structures of knowledge ecosystems. It should be noted that these structures are not the only structural forms in the literature, but tend to be the dominant structures identified in the literature.

Business ecosystems are structured as a platform around an orchestrator (Iansiti & Levien, 2004; Kapoor & Argwal, 2017). A platform connects the orchestrator, complementary organisations and users. When the platform offers a wide range of complementary services and products, it becomes attractive to users, creating a network effect (Katz & Shapiro, 1994; Rong, Ren & Shi, 2018). The platform is also the dominant structure in the innovation ecosystem literature (Dedehayir et al., 2018; Kwak et al., 2018; Lepoutre & Oguntye, 2018; Nambisan & Baron, 2012).

In the entrepreneurial ecosystem literature, the cluster is the dominant structure (Auerswald & Dani, 2017; Brown & Mason, 2017; Isenberg, 2010; Schaeffer & Matt, 2016). A cluster generally focuses on a specific industry or technology-related knowledge base and has a spatially confined character (Delgado, Porter & Stern, 2015). The entrepreneurial ecosystem is a particular variant of the cluster; it is spatially confined, but focused on entrepreneurship in general rather than clustering a particular industry. Nevertheless, the cluster structure is used in entrepreneurial ecosystems, because geographical proximity is considered a catalyst for entrepreneurship in these ecosystems (Auerswald & Dani, 2017; Brown & Mason, 2017; Schaeffer & Matt, 2016; Spigel, 2015).

4.1.7. Boundary 7: Value creation and capture

Value creation and capture is an important topic in the ecosystem literature. In each ecosystem type, the actors need each other to realise their value proposition (Shipilov & Gawer, 2020). It also follows from our analyses that the four ecosystem types differ in the use of and emphasis on value creation and/or capture mechanisms. Studies on business, innovation and knowledge ecosystems combine value creation and capture mechanisms, whereas the entrepreneurial ecosystem literature focuses on value creation. Despite the observation that value creation and capture in ecosystems have not received an equal amount of research attention, scholars do recognise that both mechanisms are equally important (Teece, 2017).

The business ecosystem literature mostly takes a single partner orientation by examining how the focal actor as well as individual ecosystem actors can capture value. The business ecosystem literature identifies the value capture mechanisms as business model innovation (Kapoor & Argwal, 2017; Li, 2009; Tellier, 2017). Studies identify value creation mechanisms as collaborative innovation processes (Clarysse et al., 2014), platform building (Kukk, Moors & Hekkert, 2015; Kwak et al., 2018) and role definition processes (Scaringella & Radziwon, 2018). The innovation ecosystem moves beyond the single partner orientation by centring on the realisation of a shared value proposition (Jacobides et al., 2018). In this literature, value creation and capture mechanisms have received comparable attention. These mechanisms seek to understand how individual actors as well as the ecosystem as a whole can capture and create value. An example of an innovation ecosystem in which both value creation and capture mechanisms are examined at the ecosystem level is a 3D printing innovation ecosystem in China. In this ecosystem, partners from science and industry jointly create knowledge and capture business value (Xu et al., 2018). Examples of value capture mechanisms in the identified innovation ecosystems are extensive intellectual property right portfolios, technology standards and business model innovation (Holgersson et al., 2018; Leten et al., 2013; Ritala et al., 2013) as well as contracts and structures (Ritala et al., 2013). Value creation mechanisms in the innovation ecosystem literature include collective uncertainty management (Gomes, Salerno, Phaal & Probert, 2018a), mutual learning (Chen, Liu & Hu, 2016), shared vision development (Gomes et al., 2018a; Ritala et al., 2013) and stakeholder engagement (Pombo-Juarez et al., 2017).

The knowledge ecosystem literature aims to understand how value creation and capture are organised at the system level. The value creation mechanisms focus on creating a community for knowledge generation and innovation. The value capture mechanisms in knowledge ecosystems focus on capturing value from the jointly developed knowledge. The knowledge ecosystem literature identifies two value creation mechanisms: innovation process facilitation and innovation community creation (Van der Borgh et al., 2012). In order to capture value, it is important to be able to reinvent the business model continuously, as different types of innovation may need different business models, and therefore, the knowledge ecosystem has to date studied a mechanism for value capture; the use of business model innovation (Van der Borgh et al., 2012). The entrepreneurial ecosystem literature has only examined value creation mechanisms (Acs, Estrin, Mickiewicz & Szerb, 2018; Bruns et al., 2017) and takes a system-level approach in explaining how this value is created. This is related to the focus of the entrepreneurial ecosystem literature: creating a stimulating entrepreneurial climate for both start-ups and larger organisations. In that sense, the organisations themselves are responsible for capturing value, and research mostly focuses on creating the right preconditions for them to do so. Value creation mechanisms in the entrepreneurial ecosystem literature include the design of the collaborative business environment and the development of entrepreneurial climates (Clarysse et al., 2014; Isenberg, 2010; Spigel, 2015). An

Table 4
Ecosystem type goal comparison.

Ecosystem type	Focal firm survival and growth	Ecosystem partner survival and growth	Sustainable and/or Social value	Knowledge generation
Business	X	X	X	
Innovation	X	X	X	
Knowledge		X		X
Entrepreneurial		X	X	

overview of the focus of the four ecosystem types in terms of value creation and capture can be found in Fig. 2.

4.2. Goals of the ecosystem types

Ecosystem types are distinct in the end towards which they are directed, or said differently, they are distinct in their goals (Hannah & Eisenhardt, 2017; Valkokari, 2015). Each ecosystem has a value proposition and an organisational structure designed to achieve the ecosystem goal (Jacobides et al., 2018; Valkokari, 2015). Scholars define the goal of an ecosystem as the constant (re)combination of artefacts, skills and ideas by ecosystem partners that results in a commonly created output based on the ecosystem's value proposition (Jacobides et al., 2018; Thomas & Autio, 2019; Valkokari, 2015). We identify several possible goals for each ecosystem type in the selected literature. The analysis shows that some goals have been extensively researched (e.g. innovation and focal firm survival), whereas more recent research examines several new goals (e.g. sustainability, social impact and social responsibility). A comparison of the ecosystem goals can be found in Table 4.

4.2.1. Nature of the goals – Firm vs. system-level focus

In the ecosystem literature, the focus of researchers regarding the nature of the goals has shifted over time. The evolution of the literature can be found in Fig. 3.

The business and innovation ecosystems originally focused on the survival and growth of a focal firm (Adner, 2006; Iansiti & Levien, 2004; Moore; 1993). In the innovation ecosystem literature, studies have moved beyond mere focal firm value; yet these studies still attribute strong importance to an orchestrator. In the business and innovation ecosystem literature, the goals at the ecosystem level are therefore always a derivative of (a select number of) the orchestrator's goals. Only recently, studies started to consider how the ecosystem partners and/or the ecosystem at large might benefit from the ecosystem goal as well. As a result, research is gradually moving from the orchestrator level to the system level. The business ecosystem literature has broadened its perspective on the survival and growth of ecosystem partners, moving beyond focal firm governance into new areas such as goal realisation in developing countries and knowledge sharing across a variety of partners (Khavul & Bruton, 2013; Wulf & Butel, 2017). A subset of innovation ecosystem studies has also started to acknowledge value capture by individual partners in the ecosystems and by the ecosystem at large (Leten et al., 2013; Mantovani & Ruiz-Aliseda, 2016; Ritala et al., 2013). Recently, there has also been a shift in the innovation ecosystem literature towards the system level, moving away from the focal firm focus (Russel & Smorodinskaya, 2018).

In contrast, as can be found in Fig. 3, the knowledge and entrepreneurial ecosystem literature inherently focus on the ecosystem level as well as goals related to partners other than the orchestrator and/or to the ecosystem at large. The focus on system-level goals is intertwined with how these ecosystems are considered to operate. In the knowledge ecosystem literature, the entire process of knowledge generation contributes to the survival of all the ecosystem partners and not just one in particular (Clarysse et al., 2014; Van der Borgh et al., 2012). The goal of entrepreneurial ecosystems is economic development on a national, regional and/or local scale (Acs et al., 2018; Bruns et al., 2017). Entrepreneurial ecosystems can thus only be successful when they contribute to the survival of individual entrepreneurs. Without the ecosystem, these entrepreneurs would have more difficulty accessing the required resources, knowledge and networks needed to support their business activities (Isenberg, 2010; Spigel, 2015).

4.2.2. Increased research interest in purposeful value creation

The change towards a more system-level type of goals also results in changes regarding the contexts in which value is created. Sustainability at large has become an important topic, and consequently, scholars have started to focus on the purpose of ecosystems and sustainability across all levels of analysis (e.g. Graca & Camarinha-Matos, 2017; Russel & Smorodinskaya, 2018; Thompson et al., 2018). As a result, purposeful value creation contexts may become more attractive to organisations and ecosystem orchestrators. We thus identify a shift away from the pure focus on (a) technological innovation and (b) innovation for the exclusive sake of partners in the ecosystem who have previously characterised ecosystem research. The focus of the entrepreneurial ecosystem literature is more strongly on socio-economic goals related to regional and national development (Auerswald & Dani, 2017; Goswami, Mitchell, & Bhagavatula, 2018). These changes seem to go hand in hand with the use of alternate theories and literature in more recent studies, such as industrial ecology,

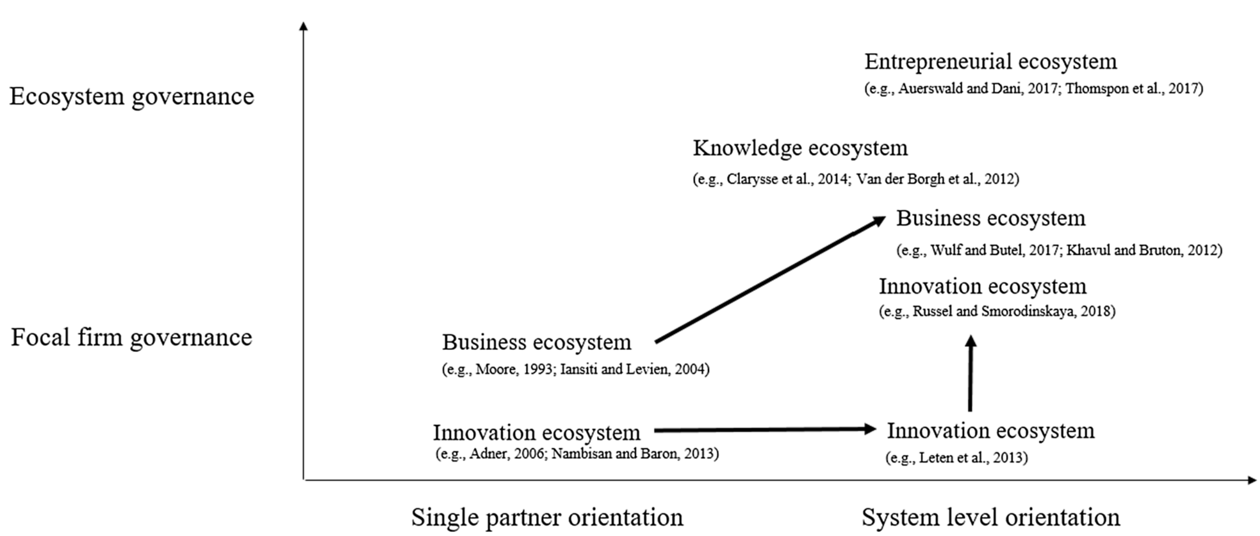

Fig. 3. Ecosystem type governance.

Table 5
Research gaps and future research directions.

Research gap	Potential research questions	Theories/ concepts that can be applied	Useful research designs
1. ***Increased attention on external environment of the ecosystem***	What is the role of external stakeholders in value proposition realisation of the ecosystem? What kind of external stakeholders influence the realisation of ecosystem value propositions? How do external stakeholders influence the value creation for an ecosystem orchestrator? What is the role of international governments in preventing ecosystems from violating privacy and regulation laws? What is the role of institutions?	Stakeholder classification (e.g. Mitchel et al., 1997) Institutional theory (e.g. Audretsch et al., 2021, Laffan, 2011) International governance (e.g. Abbott & Snidal, 2011) Privacy infringement (e.g. Gerber, Gerber & Volkamer, 2018) Governance (e.g. Ooms et al., 2020; Ritala et al., 2013)	Case study (e.g. Jarvi et al., 2018; Van de Borgh et al., 2012) Qualitative research synthesis method (e.g. Ooms et al., 2015) Social network analysis (e.g. Shipilov & Gawer, 2020) Survey (Bruns et al., 2017; Clarysse et al., 2014) Action research (Heikkilä & Kuivaniemi, 2012)
2. ***Enhance research on performance metrics***	What kind of performance dimensions and indicators can be used to measure performance of different types of ecosystems (innovation, business, knowledge and entrepreneurial)? How do 'soft' controls (culture, structure) and 'hard' controls (KPIs, processes) influence ecosystem performance? Do ecosystems need specific performance metrics depending on the type of goal they aim to achieve (e.g. commercial vs. social goals)? How do performance indicators and ecosystem evolution relate in terms of choosing appropriate indicators? What kind of concepts (e.g. health, resilience) can be used to measure the viability of ecosystems over the longer run? How can machine learning be used to understand and measure ecosystem performance?	Ecosystem health (e.g. Iansiti & Levien, 2004) Resilience (e.g. Iansiti & Richards, 2006) Modularity (e.g. Shipilov & Gawer, 2020) Institutional types and institutional change (e.g. Pop et al., 2017)	Machine learning (e.g. Rong, Lin, Yu & Radziwon, 2020) Delphi studies (e.g. Hirschhorn, Veeneman & Van de Velde, 2018; Van de Linde & Van der Duin, 2011) Case study (e.g. Jarvi et al., 2018; Van de Borgh et al., 2012) Survey (Bruns et al., 2017; Clarysse et al., 2014)
3. ***Explore research methods and research designs for ecosystem research****	What are the recurrent themes in ecosystem research? How do different ecosystem types identify value propositions? How can the social network analysis be applied in ecosystem research? How do the roles of stakeholders change over time in an ecosystem setting? How do structure, culture, KPIs, and processes change in an evolving ecosystem context?	–	Qualitative research synthesis method (e.g. Ooms et al., 2015) Social network analysis (e.g. Shipilov & Gawer, 2020) NK models (e.g. Ganco et al., 2020) Machine learning (e.g. Rong, Lin, Yu & Radziwon, 2020) Delphi studies (e.g. Hirschhorn et al., 2018; Van de Linde & Van der Duin, 2011) Grounded theory (e.g. Maysami & Elyasi, 2020) Action research (Heikkilä & Kuivaniemi, 2012)
4. ***Identify useful theories and literatures that could contribute to ecosystem research****	How can clusters be structured to enable entrepreneurship in an entrepreneurial ecosystem? How do radical innovations develop in an innovation ecosystem context? How can multilevel perspective theory be used to understand the growth of ecosystems from niches to regimes? What organizational capabilities are required for creating radical innovations in an ecosystem setting? How can ecosystem partners be intrinsically motivated to sustainable contribute to the realisation of the ecosystem's value proposition? What is the role of intrinsic motivation to create alignment	Cluster (e.g. Porter & Ketels, 2009; Russel & Smorodinskaya, 2018) Multilevel perspective theory (e.g. Geels,2004; Geels & Schot, 2007) Complex adaptive systems (e.g. Philips & Ritala, 2019) Service-dominant logic (e.g. Vargo & Lusch, 2004) Self-determination theory (e.g. Nijhuis et al., 2012) Platform (e.g. Gawer & Cusumano, 2014) Inter-organizational network (Shipilov & Gawer, 2020)	Qualitative research synthesis method (e.g. Ooms et al., 2015) Social network analysis (e.g. Shipilov & Gawer, 2020) Case study (e.g. Jarvi et al., 2018; Van de Borgh et al., 2012) Survey (Bruns et al., 2017; Clarysse et al., 2014) Grounded theory (e.g. Maysami & Elyasi, 2020) Action research (Heikkilä & Kuivaniemi, 2012)

(continued on next page)

Table 5 (*continued*)

Research gap	Potential research questions	Theories/ concepts that can be applied	Useful research designs
	for co-creation in ecosystem activities? What is the role of platform structure and intrinsic motivation of ecosystem partners in ecosystem outcome realisation?		

*: These are methods, research designs, and theories/literatures that could be used in addition to those identified with the other two research gaps.

multi-level perspective, genealogy and sustainability, all of which inherently focus on more purposeful value creation contexts.

5. Discussion: Setting an agenda for ecosystem research

This systematic literature review of four ecosystem types set out to identify the boundaries between the four ecosystem types and identify their respective goals. In total, our review yields seven boundaries and makes two thematic observations on the goals that ecosystems pursue. Our analyses allow us to determine, where the state-of-the-art in ecosystem research falls short and, thus, to suggest directions in which ecosystem research might fruitfully go. We aim to inform scholars on how future research can support the understanding of the way ecosystem boundaries enable the achievement of ecosystem goals. Furthermore, the results expose several relatively weak spots in our understanding of specific ecosystem types and ecosystem research at large. In the following, we outline a thematic research agenda for ecosystem scholars. Table 5 provides an overview of the research gaps and potential research questions as well as theories, concepts and research designs that we put on this agenda.

5.1. *Research theme* ***1: outward-looking research***

We observe that current ecosystem research tends to focus on the internal ecosystem environment rather than on the external environment of the ecosystem. This also applies to the specific context of the actors involved in the ecosystem (Möller, Nenonen & Storbacka, 2020). The contextual boundary conditions of ecosystems are under discussion (Neumeyer, Santos & Morris, 2018). For most ecosystem types, existing ecosystem research documents what actors are or should be part of in a given ecosystem and details their roles. We observe that although similar actors may be part of any ecosystem type, the roles can be distributed among partners in a very different way (e.g. a university may have a very different role in a knowledge ecosystem than in a business ecosystem). Existing research has also progressed by looking at how actors within an ecosystem can work together towards a common goal, which has provided interesting insights into ecosystems.

However, our analyses point out that an outward-looking perspective is largely missing, i.e. we know less about the role of actors who are not part of the ecosystem itself, nor much about other relevant contextual factors, while both may potentially affect the ecosystem nonetheless (Neumeyer et al., 2018). This is particularly true for ecosystems with a far-reaching (societal) impact, e.g. recent cases of lawsuits against Facebook and Google (related to their digital innovation ecosystems) on privacy and consent of user data by the ecosystem, showing how external actors of the ecosystem may be affected by it and/or affect the ecosystem itself (e.g. Cusumano et al., 2019). Such actors could range from ecosystems' users or clients to governments. Some research refers to stakeholders (e.g. Scaringella & Radziwon, 2018), but the focus is often on actors internal to the ecosystem or stakeholders related to the orchestrator at the expense of attempts to understand the role of external stakeholders vis-à-vis the ecosystem at large. Only a few studies consider ecosystems' adaptability to changes in their environment (Acs et al., 2018; Ansari, Garud & Kumaraswamy, 2016), and even fewer explicitly discuss the role of external stakeholders (Auerswald & Dani, 2017; Bruns et al., 2017). One of the few studies that considers both ecosystem's adaptability to changes in the environment as well as the role of external stakeholders in these changes is a case study by Radziwon, Bogers, Chesbrough and Minssen (2021). In this study, they observe how observed challenges and planned adaptability of a low-cost airline were forced through the pandemic to be rapidly introduced as well as how external stakeholders were largely involved to do so. Several open questions remain and call for further research. Primarily, there is a need to identify relevant (groups of) external stakeholders to ecosystem types. Secondly, it is important then to investigate how and to what extent these stakeholders may affect such an ecosystem.

5.2. *Research theme 2: Metrics*

Despite increased scholarly attention to the issue, we are still struggling to develop adequate performance metrics for ecosystems. Although several journal articles agree that having metrics for ecosystem performance is important, such metrics have received little to no attention in the ecosystem literature, and the topic of ecosystem performance metrics has, in any case, not yet been sufficiently understood (Oh, Philips, Park & Lee, 2016). Several studies have attempted to identify metrics and apply them, but they are exploratory studies (Basole, Huhtamak, Still & Russel, 2016) that are limited to qualitative analyses (Theodoraki, Messeghem & Rice, 2018), have inconclusive results (Bruns et al., 2017) or map rather than test performance indicators for ecosystems (Graca & Camarinha-Matos, 2017). Therefore, there are several opportunities for future research on ecosystem metrics. First, future research may aspire to identify fitting metrics for one or more relevant performance dimensions of ecosystems (achieving goals, satisfying partners, etc.). Second, and in relation to this, such research could attempt to create metrics that are responsive to differences between ecosystems and/or ecosystem types that may affect performance, e.g. differences in modularity or governance (Shipilov & Gawer, 2020). Third, once metrics are developed, this will enable comparative analysis of the performance of ecosystems (and ecosystem types), which will not only lead to advances in ecosystem research, but will also be useful to practitioners (e.g. it helps to benchmark the performance of their ecosystem to improve it). Fourth, future research may consider whether a narrow (i.e. economic, competitive) or a broader (i.e. economic, social, environmental) take on performance is warranted, considering our observation that literature is increasingly exploring the use of ecosystems in broader value creation contexts. In the case of a broader perspective on performance, a focus on concepts like ecosystem health or ecosystem resilience may prove more appropriate (Iansiti & Levien, 2004). Finally, future research may consider the use of new methods, such as machine learning, that could support the exploration of larger amounts of data at the ecosystem level to capture both the static and dynamic elements of ecosystem development and thereby understand the appropriate metrics for ecosystem success (Rong, Lin, Zhang & Radziwon, 2020).

5.3. *Research theme 3: Nature of ecosystem research*

We identified the methodology, research design, scope and nature of the articles from the systematically reviewed literature and developed a list of the dominant research methods and research designs used to study the four ecosystem types in the selected articles. Based on this analysis, we found that the vast majority of empirical studies of ecosystems are based on case study designs. Only a limited number of previous studies are based on survey or database research, and yet other studies were not empirical. This reaffirms observations from previous research investigating business ecosystems in particular (Kapoor, 2018). Case study research has provided ecosystem scholars with a rich understanding of the mechanisms and processes of ecosystems; however, it also makes our current understanding of ecosystems highly context-dependent and provides a low generalisability. Furthermore, the predominance of case study research leaves ample room for deductive theory-testing research on ecosystems, enabling causal inference (Jacobides et al., 2018; Suominen et al., 2019). Additionally, current research is mostly static or snapshot-based and therefore fails to capture relevant ecosystem dynamics. Only a few scholars have attempted to apply methodologies to capture these dynamics, such as data-driven network visualisation (e.g. Still, Huhtamäki, Russel & Rubens, 2014).

We therefore suggest ecosystem research to move towards research that is more deductive to test propositions from previous research as well as to test and replicate earlier research findings. To this end, we propose at least three ways to move the field forward. First, future research should have an overview of the existing, rich research findings. One potential way to acquire such an overview is to look for recurrent themes across publications to inform about research problems in future research (Scaringella & Radziwon, 2018). The current systematic literature review is a strategy to do just that. Meanwhile, there are other interesting yet underutilised methodological approaches, such as the qualitative research synthesis method, which can be used to aggregate and synthesise findings from case study research (Ooms, Caniëls, Werker, & Van den Bosch, 2015). The use of such methods will improve our abilities to generalise from existing research and can directly inform hypothesis development and testing. Second, ecosystem researchers should strive to conduct quantitative and comparative empirical research. In this regard, the application of methodologies such as social network analysis (SNA) and stochastic multicriteria acceptability analysis (SMAA) could be fruitful. According to Shipilov and Gawer (2020), the use of SNA measures previously supported advancements in organisational network research, which could spark similar advances in ecosystem research. According to Corrente, Greco, Nicotra, Romano and Shillaci (2019), the use of SMAA can support the comparison of ecosystems, e.g. to identify the factors that enable entrepreneurship in an entrepreneurial ecosystem. In this way, SMAA can support researchers to distinguish between factors based on their importance. Third, to allow for causal inference and to create an understanding of ecosystem dynamics, scholars may apply longitudinal designs or methodologies that can register the dynamics of ecosystems. Useful methods can be machine learning (natural language processing tools), qualitative comparative analysis as well as agent-based modelling and simulations inspired by NK models (e.g. Ganco, Kapoor & Lee, 2013).

5.4. Research theme 4: Theories and literature

We identified a list of theories and literature that have been used in ecosystem research across the selected articles. Despite this attempt, a limitation of our study is the lack of exploration on how the theories and literature have contributed to explaining specific phenomena in ecosystem research, which other theories could provide useful insights into and contributions to ecosystem research as well as the identification of commonalities with non-ecosystem literature, dealing with similar issues as the ecosystem literature. Some scholars theorise how other theories and literature could provide useful insights into ecosystem research. For example, Graca and Camarinha-Matos (2017) use a systematic review method to identify several research fields such as enterprise performance indicators, collaboration benefits, value systems, supply chain collaboration and social network analysis to explain how performance could be measured in business ecosystems. Another example is Autio and Thomas (2020), who use the strategic management, service marketing and information systems research fields to provide an understanding of how value is co-created in ecosystems. We therefore recommend future research to look for further integration of particular theories and literature such as the transition literature (e.g. the application of the multi-level perspective on the growth of ecosystems from niches to regimes) that can provide useful insights into and contributions to ecosystem research. Additionally, we would like to recommend future research to investigate which other theories and literature, such as Complex Adaptive Systems (Philips & Ritala, 2019) or Self-Determination Theory (Nijhuis, Van Beek, Taris & Schaufeli, 2012), could inform ecosystem research to, among other things, advance our understanding of the relational perspective of organisations within ecosystems. Furthermore, we urge future research to continue examining how present ecosystem studies relate to existing theories and literature, thereby further theorising the concept, as current theory development on ecosystems is still limited (Jacobides et al., 2018; Suominen et al., 2019). Lastly, there are several recent conceptual developments that fall under the wide umbrella of innovation ecosystems, such as works on industry and digital platforms (e.g. Cusumano et al., 2019; Gawer & Cusumano, 2014), that provide interesting and new insights into how the ecosystem phenomenon develops over time. Such research shows that although ecosystems in general may have a certain geographical scope, specific types of ecosystems can stretch or abandon that scope due to their digital nature. Integrating this research with innovation ecosystems research could generally support the maturation of ecosystem research. Moreover, as digital transformation is no longer an organisational level phenomenon, future studies on ecosystems and more specifically digital ecosystems are expected to further contribute to the theory development in the area of digital affordances, orchestration and self-organisation (Dabrowska et al., 2021).

6. Managerial recommendations

A substantial part of the reviewed journal articles provide suggestions for ecosystem orchestrators and partners to participate, lead and/ or contribute to an ecosystem. These suggestions and the insights from our review have inspired us to derive two managerial implications specifically for ecosystem partners and policymakers as well as a teaching implication.

First, we recommend that both ecosystem partners and policymakers use metrics to inform their decision-making. Metrics provide a snapshot of the ecosystem to understand its current situation and to check whether the strategic objectives of both ecosystem partners and the ecosystem as a whole have been realised. In this way, policymakers can, for example, observe whether the objectives for a specific subsidy have been achieved. When necessary, specific ecosystem partners, leaders or policymakers can intervene accordingly. Until now, ecosystem success has focused on ecosystem performance in a competitive sense (Iansiti & Richards, 2006), but the shift towards new value creation contexts requires ecosystem stakeholders to look beyond mere competitive performance to more inclusive ways of measuring success or, as referred to by some, measuring the ecosystem's health (Surie, 2017). Measuring the success and resilience of the ecosystem in more inclusive ways can be useful for policymakers, as it can support their legitimisation of ecosystem participation and sponsorship for society as a whole. Metrics can support the ecosystem in understanding its dynamics, efficiency and evolution. We therefore recommend ecosystem orchestrators and partners to explore which metrics may fit the strategic objectives of ecosystems in order to adjust their behaviour accordingly (Surie, 2017).

Second, we recommend practitioners to look beyond the internal ecosystem and focus on understanding the ecosystem's external environment as well. The examples of Google and Facebook (Cusumano et al., 2019) show that it is more important than ever to take the external environment into consideration, as the impact of global ecosystems affects both the internal and external environment of ecosystems. To increase the resilience of the ecosystem, it is important to understand the role of external stakeholders, such as institutional actors (e.g. law and policymakers) in the ecosystem's success. By understanding their roles and impacts, it becomes easier for the ecosystem partners to make the ecosystem less vulnerable to external shocks or pressures (e.g. Cusumano et al., 2019) and better able to build long-term trust-based relationships (Surie, 2017). An example of a case in which the orchestrator was able to integrate an external actor in the ecosystem, is the PRoF teaching case. This case explains how the ecosystem orchestrator began to integrate local and regional governments into their ecosystem over time to create synergies rather than treating governments as a rigid stakeholder (Ivey, 2021). This type of teaching case can support both policymakers and practitioners in understanding how the external environment can be properly integrated into the ecosystem. When policymakers understand not only the internal but also the external environment of ecosystems, they are better able to hold organisations responsible for (negative) impacts on society. In line with the suggestion from Freeman (1984) to create value for all stakeholders, we therefore recommend ecosystem partners to analyse which external stakeholders could influence the ecosystem, what their interests are, and how powerful they are in order to be better equipped to build a resilient ecosystem.

Lastly, we recommend companies, governments and educational institutions to educate the ecosystem orchestrators and partners of the future. Ecosystem orchestration and participation require a different mindset compared to traditional (internally focused) business management. Some educational programmes are still aimed at teaching more traditional management theories and practices rather than training the required skills and knowledge for ecosystem participation. In terms of intrinsic motivation, for example, theories have generally focused on understanding how the motivation of internal employees can be stimulated by making changes in their work environment, among other things (e.g. Nijhuis et al., 2012). In an ecosystem context, motivation has to be understood across organisational boundaries in order to be able to motivate members from different organisation types. Teaching cases can stimulate future orchestrators and partners' understanding of what ecosystems need to be successful and how alignment can be developed. An example of such a teaching case is the Curana case: a small company that became a value chain orchestrator in the bicycle industry. The teaching case inspires students on how a small firm can take the lead in managing an ecosystem, and what the firm did to do so (Harvard Business Review, 2017).

7. Concluding remarks

The purpose of this systematic literature review was to provide a review of ecosystem boundaries and to identify which ecosystems could enable the realisation of ecosystem type-specific goals as well as to create an overview of future research directions required to understand how ecosystem boundaries enable the achievement of ecosystem goals. We identified the theoretically illuminating similarities and differences between four ecosystem concepts by examining ways in which boundaries are drawn across contexts and types of ecosystems. We moved beyond existing studies focusing on the individual type of an ecosystem (Adner & Kapoor, 2010; Li, 2009; Spigel & Harrison, 2017; Van der Borgh et al., 2012) and built on a limited number of systematic attempts to study ecosystem types in unison (Dedehayir et al., 2018; Han et al., 2017; Scaringella & Radziwon, 2018; Valkokari, 2015). However, our review has been more open to the evolutionary nature of ecosystems and their goals, the relevance of both ecosystem-level and partner-level goals as well as the notion that the goals of an ecosystem are likely to be multifaceted. The boundaries we identified are in seven dimensions of the ecosystem types: (1) competitive advantage, (2) geographical scope, (3) ecosystem development, (4) orchestration, (5) actor types and roles, (6) structure and (7) value creation and capture. Regarding the goals of the ecosystems, we identified differences in the level at which goals are pursued. We reaffirmed some trends in the field that others had identified, such as the change from individualistic to group-level analysis (Thomas & Autio, 2019) and the relation between different ecosystem types (Thomas & Autio, 2019; Scaringella & Radziwon, 2018). However, our systematic literature review has also led to important new findings as well as the following fourfold contributions. First, we contribute to the literature by building a common understanding of the conceptual boundaries of the ecosystems through identifying and discussing four main types of ecosystems. Moving beyond existing studies focusing on single ecosystem types and their boundary conditions (Aarikka-Stenroos & Ritala, 2017; Shipilov & Gawer, 2020), we contribute to the literature by comparing – instead of describing – the four ecosystem types, thereby showing how the four ecosystem types differ from each other. Second, we contribute to the literature by identifying and discussing how the ecosystem has developed over time, showing a shift from the mere focal firm/single partner orientation towards a system-level orientation. By defining ecosystem goals as commonly created outputs based on a value proposition rather than just a common intention (Valkokari, 2015), we contribute to understanding the diversity of the ecosystem goals that each ecosystem type aims to achieve. In addition, we have looked at the evolution of the ecosystem goals over time as described in the literature, and we thereby go beyond previous studies that either took a more static perspective on ecosystem goals or focused on a limited number of goal types (Russel & Smorodinskaya, 2018; Thomas & Autio, 2019). Third, we contribute to the literature by systematically demarcating ecosystem types by accounting for (and distinguishing between) their conceptual boundaries and ecosystem-specific goals (Scaringella & Radziwon, 2018; Thomas & Autio, 2019; Valkokari, 2015). By doing so, we counteract the conceptual proliferation of the ecosystem research landscape, converging and moving in the opposite direction. Our multifaceted conceptualisation provides a better understanding of the four ecosystem types, thereby improving the academic rigour of the ecosystem field. Our approach uses a systematic review that is more rigorous than recent narrative reviews. Lastly, we propose a research framework based on ecosystem boundaries and ecosystem goals that will constitute a conceptual basis for identifying the future research agenda.

CRediT authorship contribution statement

Dieudonnee Cobben: Writing – original draft preparation, Visualization, Conceptualization, Methodology, Formal analysis, Investigation. **Ward Ooms:** Writing – original draft preparation, Writing – reviewing & editing, Conceptualization, Formal analysis. **Nadine Roijakkers:** Supervision, Writing – original draft preparation, Writing – reviewing & editing, Formal analysis. **Agnieszka Radziwon:** Writing – original draft preparation, Validation, Writing – reviewing & editing, Formal analysis.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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[1] The special issue "Entrepreneurial ecosystems: economic, technological, and societal impacts" in the Journal of Technology Transfer by David B. Audretsch, James A. Cunningham, Donald F. Kuratko, Erik E. Lehmann and Matthias Menter (2019)

provides additional in-depth information and insights on entrepreneurial ecosystems as well as proposes new methodologies to study other ecosystem types.

Appendix A. Search strings and total articles

See Table 6.

Table 6
Search strings and total articles.

Search	Keyword strings	Total (including only management, business engineering industrial, or economics)	Total (without duplicates)	Total (incl. other categories than management, business, economics and engineering industrial)
1	Ecosystem* AND innovat* AND business*	380		602
2	Ecosystem* AND business* AND entrep*	175		245
3	Ecosystem* AND business* and knowl*	165		333
4	Ecosystem* AND innovat*	327		3762
5	Ecosystem* AND business*	172	171	1953
6	Ecosystem* AND entrep*	371		630
7	Ecosystem* AND knowl*	46		17,242
8	Ecosystem* AND innovate* AND entrep*	4		9
9	Ecosystem* AND business* AND network*	210		429
10	Ecosystem* AND entrepreneurial* AND network*	67		92
11	Ecosystem* AND innovat* AND network*	276		679
12	Ecosystem AND inovate* NOT business* NOT system* NOT entrep*	5		25
13	Ecosystem NOT innovate* AND business* NOT system* NOT entrep*	285		971
14	Ecosystem NOT innovate* NOT business* AND system* NOT entrep*	1045		63,798
15	Ecosystem NOT innovate* NOT business* NOT system* AND entrep*	114		228
16	Ecosystem* AND innovate* AND orchestration*	0		0
17	Ecosystem* AND business* AND orchestration*	11		15
18	Ecosystem* AND business* AND actor*	79		170
19	Ecosystem* AND innovat* AND actor*	10		287
20	Ecosystem* AND business* AND system*	262	261	807
21	Ecosystem* AND entrepreneurial* AND system*	97		136
Total		2461	2459	78,228 total (excl. duplicates)

Appendix B. Overview of articles

See Table 7.

Table 7
Overview of articles.

Number	Authors	Title	Year	Journal
1	Scaringella and Radziwon	Innovation, entrepreneurial, knowledge, and business ecosystems: Old wine in new bottles?	2018	Technological Forecasting & Social Change
2	Van der Borgh et al.	Value creation by knowledge-based ecosystems: evidence from a field study	2012	R&D Management
3	Jarvi et al.	Organization of knowledge ecosystems: Prefigurative and partial forms	2018	Research Policy
4	Clarysse et al.	Creating value in ecosystems: Crossing the chasm between, knowledge and business ecosystems	2014	Research Policy
5	Adner	Match your innovation strategy to your innovation ecosystem	2006	Harvard Business Review
6	Carayannis and Campbell	'Mode 3' and 'Quadruple Helix': Toward a 21st century fractal innovation ecosystem	2009	International Journal of Technology Management
7	Walrave et al.	A multi-level perspective on	2018	

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Table 7 (*continued*)

Number	Authors	Title	Year	Journal
		innovation ecosystems for path-breaking innovation		Technological Forecasting & Social Change
8	Xu et al	Exploring innovation ecosystems across science, technology, and business: A case of 3D printing in China	2018	Technological Forecasting & Social Change
9	Dedehayir et al.	Roles during innovation ecosystem genesis: A literature review	2018	Technological Forecasting & Social Change
10	Gomes et al.	Unpacking the innovation ecosystem construct: Evolution, gaps and trends	2018	Technological Forecasting & Social Change
11	Shaw and Allen	Studying innovation ecosystems using ecology theory	2018	Technological Forecasting & Social Change
12	Russel and Smorodinskaya	Leveraging complexity for ecosystemic innovation	2018	Technological Forecasting & Social Change
13	Luo	Architecture and evolvability of innovation ecosystems	2018	Technological Forecasting & Social Change
14	Kolloch and Dellermann	Digital innovation in the energy industry: The impact of controversies on the evolution of innovation ecosystems	2018	Technological Forecasting & Social Change
15	Kwak et al.	Complementary multiplatforms in the growing innovation ecosystem: evidence from 3D printing technology	2018	Technological Forecasting & Social Change
16	Leten et al.	IP Models to Orchestrate Innovation Ecosystems: IMEC, a public research institute in nano-electronics	2013	California Management Review
17	Holgersson et al.	The evolution of intellectual property strategy in innovation ecosystems: Uncovering complementary and substitute appropriability regimes	2018	Long Range Planning
18	Ritala et al.	Value creation and capture mechanisms in innovation ecosystems: A comparative case study	2013	International Journal of Technology Management
19	Gomes et al.	How entrepreneurs manage collective uncertainties in innovation ecosystems	2018	Technological Forecasting & Social Change
20	Lepoutre and Oguntoye	The (non–) emergence of mobile money systems in Sub-Saharan Africa: A comparative multilevel perspective of Kenya and Nigeria	2018	Technological Forecasting & Social Change
21	Nambisan and Baron	Entrepreneurship in Innovation Ecosystems: Enterpreneurs' Self-Regulatory Processes and their Implications for New Venture Success	2012	Entrepreneurship Theory & Practice
22	Still et al.	Insights for orchestrating innovation ecosystems: the case of EIT ICT Labs and data-driven network visualisations	2014	International Journal of Technology Management
23	Kukk et al.	The complexities in system building strategies – The case of personalized cancer medicines in England	2015	Technological Forecasting & Social Change
24	Oh et al.	Innovation Ecosystems: a critical examination	2016	Technovation
25	Chen et al.	Establishing a CoPs-based innovation ecosystem to enhance competence – the case of CGN in China	2016	International journal of technology management
26	Brown and Mason	Looking inside the spiky bits: a critical review and conceptualization	2017	Small Business Economics
27	Bruns et al.	Searching for the existence of Entrepreneurial ecosystems	2017	Small Business Economics
28	Sussan and Acs	The Digital Entrepreneurial Ecosystem	2017	Small Business Economics
29	Miller and Acs	The campus as entrepreneurial ecosystem: The university of Chicago	2017	Small Business Economics
30	Auerswald and Dani	The adaptive lifecycle of entrepreneurial ecosystems: the biotechnology cluster	2017	Small Business Economics
31	Kuratko et al.	The paradox of New venture legitimation in an entrepreneurial ecosystem	2017	Small Business Economics
32	Isenberg	How to start an entrepreneurial revolution	2010	Harvard Business Review
33	Brem and Radziwon	Efficient Triple Helix collaboration	2017	

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Table 7 (*continued*)

Number	Authors	Title	Year	Journal
		fostering local niche innovation projects – A case from Denmark		Technological Forecasting & Social Change
34	Spigel and Harrison	Toward a process theory of entrepreneurial ecosystems	2017	Strategic Entrepreneurship Journal
35	Theodoraki et al.	A social capital approach to the development of sustainable entrepreneurial ecosystems: an explorative study	2018	Small Business Economics
36	Acs et al.	Entrepreneurship, institutional economics, and economic growth: an ecosystem perspective	2018	Small Business Economics
37	Schaeffer and Matt	Development of academic entrepreneurship in a non-mature context: the role of the university as hub-organisation	2016	Entrepreneurship & Regional Development
38	Motoyoma and Knowlton	From resource munificence to ecosystem integration: the case of government sponsorship in St. Louis	2016	Entrepreneurship & Regional Development
39	Carayannis et al.	The ecosystem as helix: an exploratory theory-building study of regional co-opetitive entrepreneurial ecosystem as Quadruple/ Quintuple Helix Innovation Models	2017	R&D Management
40	Spigel	The relational organization of entrepreneurial ecosystems	2017	Entrepreneurship Theory and Practice
41	Roundy et al.	The emergence of entrepreneurial ecosystems: A complex adaptive systems approach	2018	Journal of Business Research
42	Goswami et al.	Accelerator expertise: understanding the intermediary role of accelerators in the development of the Bangalore Entrepreneurial ecosystem	2018	Strategic Entrepreneurship journal
43	Thompson et al.	How entrepreneurial ecosystems take form: Evidence from social impact initiatives in Seattle	2018	Strategic Entrepreneurship journal
44	Ben Mahmoud-Jouini and Charue-Duboc	Experimentations in emerging innovation ecosystems: specificities and roles. The case of	2017	International Journal of Technology Management

Table 7 (*continued*)

Number	Authors	Title	Year	Journal
		the hydrogen fuel cell		
45	Pombo-Juarez et al.	Wiring up multiple layers of innovation ecosystems: Contemplations from personal health Systems Foresight	2017	Technological Forecasting & Social Change
46	Ritala and Almpanopoulou	In defense of 'eco' in innovation ecosystem	2017	Technovation
47	Mantovani and Ruiz-Aliseda	Equilibrium Innovation Ecosystems: the dark side of collaborating with complementors	2016	Management Science
48	Stead and Stead	The Coevolution of sustainable strategic management in the global marketplace	2013	Organization & Environment
49	Moore	Predators and prey: a new ecology of competition	1993	Harvard Business Review
50	Tsujimoto et al.	A review of the ecosystem concept – Towards coherent ecosystem design	2018	Technological Forecasting & Social Change
51	Wei et al.	The fit between technological innovation and business model design for firm growth: evidence from China	2014	R&D Management
52	Adner and Kapoor	Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations	2010	Strategic Management Journal
53	Pierce	Big losses in ecosystem niches: how core decisions drive complementary product shakeouts	2009	Strategic Management Journal
54	Battistella et al.	Methodology of business ecosystem network analysis: A case study in Telecom Italia Future Centre	2013	Technological Forecasting & Social Change
55	Wulf and Butel	Knowledge sharing and collaborative relationships in business ecosystems and networks	2017	Industrial Management & Data Systems
56	Nieuwenhuis et al.	The shift to cloud computing: the impact of disruptive technology on the enterprise software business ecosystem	2018	Technological Forecasting & Social Change
57	Aaldering et al.	Analyzing the impact of industry sectors on the composition of the business ecosystem: A combined	2018	Expert Systems with Applications

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Table 7 (*continued*)

Number	Authors	Title	Year	Journal
		approach using ARM and DEMATEL		
58	Dedehayir and Makinen	Measuring industry clockspeed in the systemic industry context	2011	Technovation
59	Basole et al.	Visual decision support for business ecosystem analysis	2016	Expert Systems with Applications
60	Priem et al.	Toward reimaging strategy research: retrospection and prospection on the 2011 AMR decade award article	2013	Academy of Management Review
61	Makinen et al.	Investigating adoption of beta free applications in a platform-based business ecosystem	2014	Journal of Product Innovation Management
62	Suh and Sohn	Analyzing technological convergence trends in a business ecosystem	2015	Industrial Management & Data Systems
63	Visnjic et al.	Governing the city: unleashing value from the business ecosystem	2016	California Management Review
64	Kapoor and Lee	Coordinating and competing in ecosystems: how organizational forms shape new technology investments	2013	Strategic Management Journal
65	Khavul and Bruton	Harnessing innovation for change: Sustainability and Poverty in Developing Countries	2013	Journal of Management Studies
66	Lu et al.	Business ecosystem and stakeholders' role transformation: Evidence from Chinese emerging electric vehicle industry	2014	Expert Systems with Applications
67	Wang et al.	Topological analysis of a two coupled evolving networks model for business systems	2009	Expert Systems with Applications
68	Nishino et al.	Effects of ability difference and strategy imitation on cooperation network formation: A study with game theoretic modeling and multi-agent simulation	2018	Technological Forecasting & Social Change
69	Rong et al.	Business model dynamics and business ecosystems in the emerging 3D printing industry	2018	Technological Forecasting & Social Change
70	Rong et al.	The determinants of network effects: Evidence from online games business ecosystems	2018	Technological Forecasting & Social Change
71	Rong et al.	Understanding business ecosystem	2015	International Journal of

Table 7 (*continued*)

Number	Authors	Title	Year	Journal
		using a 6C framework in Internet-of-Things based sectors		Production Economics
72	Rong et al.	Nurturing business ecosystems for growth in a foreign market: Incubating, identifying and integrating stakeholders	2015	Journal of International Management
73	Rong et al.	Nurturing business ecosystems to deal with industry uncertainties	2012	Industrial Management & Data Systems
74	Gomez-Uranga et al.	Epigenetic Economic Dynamics: The evolution of big internet business ecosystems, evidence for patents	2014	Technovation
75	Graca and Camarinha-Matos	Performance indicators for collaborative business ecosystems – Literature review and trends	2017	Technological Forecasting & Social Change
76	Kang and Downing	Keystone effect on entry in two-sided markets: An analysis of the market entry of WiMAX	2015	Technological Forecasting & Social Change
77	Liu and Rong	The nature of the co-evolutionary process: complex product development in the mobile computing industry's business ecosystem	2015	Group & Organization Management
78	Tellier	Whatever happened to the 'great escape'? lessons from the rise and decline of the pinball ecosystem	2017	International Journal of Technology Management
79	Luo and Triulzi	Cyclic dependence, vertical integration and innovation: The case of Japanese electronics sector in the 1990s	2018	Technological Forecasting & Social Change
80	El Sawy et al.	How LEGO built the foundations and enterprise capabilities for digital leadership	2016	MIS Quarterly Executive
81	Li	The technological roadmap of Cisco's business ecosystem	2009	Technovation
82	Iansiti and Levien	Strategy as ecology	2004	Harvard Business Review
83	Kapoor and Argwal	Sustaining superior performance in business ecosystems: Evidence from Application Software Developers in the iOS and Android smartphone ecosystems	2017	Organization Science

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Table 7 (*continued*)

Number	Authors	Title	Year	Journal
84	Adner and Kapoor	Innovation ecosystems and the pace of substitution: re-examining technology S-curves	2015	Strategic Management Journal
85	Mack and Mayer	The evolutionary dynamics of entrepreneurial ecosystems	2016	Urban Studies
86	Neck et al.	An Entrepreneurial system view of new venture creation	2004	Journal of Small Business Management
87	Cohen	Sustainable Valley Entrepreneurial ecosystem	2006	Business Strategy and the Environment
88	Spigel	The relational organization of entrepreneurial ecosystems	2015	Entrepreneurship Theory and Practice

Appendix C. Journal characteristics

See Table 8.

Table 8
Journal characteristics.

Author	Ecosystem type(1 = Business, 2 = Innovation, 3 = Entrepreneurial, 4 = Knowledge)	Methodology (1 = Case study, 2 = Survey 3 = Database 4 = N. A.)	Nature (1 = Conceptual, 2 = Methodological, 3 = Empirical, 4 = Review)	Key contribution	Ecosystem goal	Unit of analysis (based on Thomas & Autio, 2019)	Empirical context
Scaringella and Radziwon	1; 2; 3; 4	3	4	Linking ecosystem and territorial approaches in an evolutionary umbrella	–	Regional/Spatial	
Van de Borgh et al.	4	1	3	Identifying the relations between individual firms' business model and the ecosystem's business model at large in terms of value creation and capture	KE: Innovative output	Business model	Science park, the Netherlands – regional
Jarvi et al	4	1	3	Distinct knowledge ecosystems searching for a knowledge domain and within an identified knowledge domain/ organisation of ecosystems	KE: Engines for growth and well-being/joint knowledge search/ know-ledge exploration	Ecosystem partner	Research programmes, Finland – national
Clarysse et al.	1; 4	2	3	Existence of relation between business and knowledge ecosystems and their tensions	KE: Technological innovation advance-ments BE: Competitive advantage for individual companies	Ecosystem partner	Start-ups, Flanders, Belgium – regional
Adner	2	4	1	Relationship between ecosystem strategy and the mitigation of partner risks	IE: Profitable innovations	(Focal) firm	–
Carayannis and Campbell	2	4	1	Introducing the Mode 3 Innovation ecosystem concept and its implications for the knowledge state	IE: Innovation acceleration	National level/ Spatial	
Walrave et al.	2	4	1	Adding the importance of external viability concept in innovation ecosystems in a socio-technical environment.	IE: Path-breaking innovations	Value proposition	–
Xu et al.	2	1	3	Introducing the innovation ecosystem as a synergy and symbiosis of technology, science	IE: Cultivation of favourable business environments and	Value chain	3D printing, China – country

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Table 8 (*continued*)

Author	Ecosystem type(1 = Business, 2 = Innovation, 3 = Entrepreneurial, 4 = Knowledge)	Methodology (1 = Case study, 2 = Survey 3 = Database 4 = N. A.)	Nature (1 = Conceptual, 2 = Methodological, 3 = Empirical, 4 = Review)	Key contribution	Ecosystem goal	Unit of analysis (based on Thomas & Autio, 2019)	Empirical context
				and business sub-ecosystems, when considering the integrated value chain and interactive network.	local innovator encouragement		
Dedehayir et al.	2	3	4	Understanding detailed roles in the innovation ecosystem genesis in innovation ecosystems	IE: New Product Development (NPD) processes	Ecosystem participant	
Gomes et al.	2	3	4	Identifying the conceptual differences and evolution in the ecosystem research field		Ecosystem	
Shaw and Allen	2	1	3	Comparing natural and innovation ecosystem to create an understanding of the basic mechanisms of complex interactions among actors in innovation ecosystems	IE: Smart City	Business model	Digital health applications, United Kingdom – national
Russel and Smorodinskaya	2	3	4	Providing conceptual base for ecosystem research and practice resting on complexity science	IE: Sustainable growth	Ecosystem	
Luo	2	1; 4	2; 3	Showing the relation between technology configuration and selection capacity of diversity in value chains	IE: Firm's management of participation architectures	Technology	Electronic and Automobile industry – industry
Kolloch and Dellermann	2	1	3	Emphasising that both human and technological actors influence ecosystem evolution via controversies	IE: Digital innovation management	Ecosystem participant	Virtual power plant, Germany – regional
Kwak et al.	2	1	3	Introducing the multi-platform definition to explain that innovation ecosystems are nurtured by platforms	IE: Ecosystem growth	Value appropriation	3D printing industry – industry
Leten et al.	2	1	3	Illustrating the instrumental role of an IP-based orchestration model for value appropriation for ecosystem partners	IE: Ecosystem value appro-priation	Governance	Public research organisation, Belgium – regional
Holgersson et al.	2	1	3	Describing and analysing the co-evolution of strategic IP management and innovation ecosystems	IE: Strategic IP management for value appro-priation	Patents /IP	Mobile telecommunications systems – industry
Ritala et al.	2	1	3	Providing evidence on facilitation of IEs and underlying structures and mechanisms related to focal firm's IE orchestration	IE: Value appro-priation at partner and ecosystem level	Value appro-priation	ICT and aerospace and defence sector ecosystems, Europe – continental
Gomes et al.	2	1	3	Understanding how entrepreneurs manage collective uncertainties	IE: Collective uncertainty management	Entrepreneurial decisions	Technology-based start-ups, Brazil and Europe – global
Lepoutre and Oguntoye	2	1	3	Understanding that mobile ecosystem emergence requires a combination of institutional and economic mechanisms	IE: Mobile ecosystem emergence	Ecosystem services	Mobile money systems, Kenya and Nigeria – national
Nambisan and Baron	2	4	1	Exploring how roles of entrepreneurs' self-regulatory processes influence the balancing of ecosystem and individual interests	IE: Ecosystem entrepreneurship	Ecosystem participant (entrepreneur)	–

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Table 8 (*continued*)

Author	Ecosystem type(1 = Business, 2 = Innovation, 3 = Entrepreneurial, 4 = Knowledge)	Methodology (1 = Case study, 2 = Survey 3 = Database 4 = N. A.)	Nature (1 = Conceptual, 2 = Methodological, 3 = Empirical, 4 = Review)	Key contribution	Ecosystem goal	Unit of analysis (based on Thomas & Autio, 2019)	Empirical context
Still et al.	2	1	2	Showing how data-driven network visualisations can be used to produce insights for innovation ecosystem orchestration	IE: Shared vision and orchestration support of transforma-tions	Network orchestration	ICT Research organisation, Europe – continental
Kukk et al.	2	1	3	Illustrating how system builders within TIS deal with different technological co-dependencies and organisational complexities in their strategic activities	IE: Implemen-tation and diffusion of co-dependent technologies	Ecosystem participant activities	Pharmaceuti-cals sector, England – national
Oh et al.	2	4	1	Providing critical review of the IE concept	–	Ecosystem	–
Chen et al.	2	1	3	Presenting a framework to explicate the micro-foundations of the formation mechanisms of an innovation ecosystem	IE: Complex product system development	Ecosystem partner	Nuclear power plant, China – regional
Brown and Mason	3	4	1	Developing a preliminary taxonomy of archetypal ecosystems	EE: High-growth venture creation	Ecosystem	–
Bruns et al.	3	2	2	Proposing a method by which, if present, EE reveal themselves in the data	EE: Economic growth	Regional/ spatial	European regions, Europe – regional
Sussan and Acs	3	4	1	Introducing a conceptual framework for digital entrepreneurial ecosystem concept	EE: High-impact entrepreneurship	Ecosystem participant	–
Miller and Acs	3	1	3	Exploring governance of campus as entrepreneurial ecosystem and produced output of the campus ecosystem	EE: Economic growth	Ecosystem participant	University, United States – national
Auerswald and Dani	3	1	3	Proposing an empirical framework to assess the vibrancy and trajectory of regional entrepreneurial ecosystems	EE: Sustainable regional development	Ecosystem	Biotechnology cluster, United States – regional
Kuratko et al.	3	4	1	Proposing conceptual framework to describe how venture newness influences legitimation strategies	EE: New entrepreneurial venture success	Ecosystem legitimation strategies	–
Isenberg	3	4	1	Identifying prescriptions for entrepreneurial ecosystem creation	EE: Self-sustaining venture creation	Ecosystem	–
Brem and Radziwon	3	1	3	Offering set of factors and guidelines that could foster entrepreneurial niche innovation projects	EE: high-tech develop-ments and entrepre-neurs	Ecosystem	Energy Industry, Denmark – regional
Spigel and Harrison	3	4	1	Developing framework to explain evolution and transformation of EE and creating EE structure typology	EE: high-growth venture creation	Ecosystem	–
Theodoraki et al.	3	1	3	Creating a better conceptual understanding of sustainability and performance of EE through social capital theory	EE: Regional economic development	Ecosystem	University business incubator, South-France – regional
Acs et al.	3	2	3	Finding support for the role of the entrepreneurial ecosystem in stimulating economic growth	EE: Economic growth	National System of Entrepreneurship	Worldwide countries – national

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Table 8 (*continued*)

Author	Ecosystem type(1 = Business, 2 = Innovation, 3 = Entrepreneurial, 4 = Knowledge)	Methodology (1 = Case study, 2 = Survey 3 = Database 4 = N. A.)	Nature (1 = Conceptual, 2 = Methodological, 3 = Empirical, 4 = Review)	Key contribution	Ecosystem goal	Unit of analysis (based on Thomas & Autio, 2019)	Empirical context
Schaeffer and Matt	3	1	3	Showing how the evolving roles of a university and its TTO stimulate academic entrepreneurship and how these roles influence the maturity process of entrepreneurial ecosystem	EE: Social and economic regional development	Ecosystem partners	University, France - regional
Motoyoma and Knowlton	3	1	3	Showing the importance for government sponsorship to facilitate the interaction between entrepreneurs and different elements (e.g. finance, government, sector, etc.) of the ecosystem	EE: Increased financial performance of sponsored firms	Ecosystem partner	Government sponsorship program, the United States – local
Carayannis et al.	3	4	1	Providing theoretical framework for the study and design of ecosystems embedded within a quadruple/quintuple helix context	EE: regional business model innovation	Ecosystem	–
Spigel	3	1	3	Examining attributes of entrepreneurial ecosystems, their relationships and how they influence the competitive-ness of new firms	EE: high entrepreneurship rates	Ecosystem attributes	Technological innovation areas, Canada – regional
Roundy et al.	3	4	1	Providing a framework for the study of entrepreneurial ecosystems by building upon complexity sciences	EE: Regional economic development	Individual and organisa-tional	–
Goswami et al.	3	1	3	Showing that accelerators act as intermediaries in regional entrepreneurial ecosystems through commitment engagement, venture development and ecosystem development processes	EE: regional economic growth	Ecosystem partner	Specific region, India – regional
Thompson et al.	3	1	3	Showing that entrepreneurial ecosystems form through endogenous, bottom-up, and time-patterned processes	EE: Social impact	Ecosystem partner	Social impact companies, the United States – local
Ben Mahmoud-Jouini and Charue-Duboc	2	1	3	Understanding the emergence of innovation ecosystems and the processes and tools that support it	IE: Systemic and complex innovations	Ecosystem project	Hydrogen energy, multinational company – global
Pombo-Juarez et al.	2	1	3	Further developing the multi-layered foresight by addressing multiple layers of the innovation ecosystem in foresight design and management	IE: Momentum for rapid change, different for different spatial levels	Spatial	Foresight programme, Europe – relations between local, regional, national and international
Ritala and Almpanopoulou	2	4	1	Examining pathways to resolve issues point out by Oh et al. (2016)	–	Ecosystem	–
Mantovani and Ruiz-Aliseda	2	4	1	Showing the settings that in which a firm is confronted by rivals that can build ecosystems on equal footing	IE: Firm's maximum value capture	Ecosystem partner	–
Stead and Stead	1	4	1			Ecosystem	–

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Table 8 (*continued*)

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				Showing that business ecosystems provide excellent structures for implementing sustainable strategic management strategies along the developed, the developing and underdeveloped countries	BE: Serving the needs of the whole economic pyramid		
Moore	1	4	1	Introducing the business ecosystem concept and its phases of evolution	BE: Sustainable competitive advantage	Focal firm	–
Tsujimoto et al.	1	3	4	Reviewing literature on the ecosystem concept and identifying four research streams (i.a. business ecosystem) and an integrated model of these streams	–	Ecosystem	–
Wei et al.	1	2	3	Showing that explorative and exploitative innovation fit with different business models to stimulate growth	BE: Firm growth	Ecosystem partner	Firms, China – national
Adner and Kapoor	2	1	3	Showing that the effects of external innovation challenges depend on the magnitude and location in the ecosystem relative to the focal firm	IE: successful innovations	Financial statistics	Semiconductor lithography equipment industry – global
Pierce	1	1	3	Showing the relation between core companies' decisions and niche players' performance in business ecosystem shakeouts	BE: Niche market firm survival	Financial transactions	Automotive, California, the United States – regional
Battistella et al.	1	1	2	Proposing a methodology for the analysis and modelling of ecosystems as interacting network structures	BE: Technological innovation	Ecosystem partner	Telecom industry, Italy – national
Wulf and Butel	1	1	3	Showing how the structure of collaborative relationships in business networks may determine successful knowledge sharing in business ecosystems	BE: improved decision making and business performance	Ecosystem partner	Industrial sectors, Germany and Italy – national
Nieuwenhuis et al.	1	1	3	Understanding how the value network changes when shifting from on-premise to cloud technology	BE: migrating towards Cloud-based enterprise software	Ecosystem partner	Cloud computing solutions, Germany and the United States – national
Aaldering et al.	1	1	2;3	Proposing a framework to analyse the impact of industry sectors on the composition of business ecosystems from an industry-wide perspective based on strategic alliance and joint venture data	BE: technologi-cal development	Industry	Joint ventures and strategic alliances, worldwide – global
Dedehayir and Makinen	1	1	3	Developing an additional measure of industry clock speed (technological clock speed) for systemic industry contexts	BE: technologi-cal system	Industry	Personal computer industry, the United States – national
Basole et al.	1	4	2	Comparatively evaluating the effectiveness of three visualisation methods and the influence of data	BE: decision-making support	–	–

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				complexity, task type and user characteristics on decision performance in business ecosystem analysis			
Priem et al.	1	4	1	Offering an expanded boundary model that includes the demand side, business models and business ecosystems within the strategy research umbrella	–	Strategy	–
Makinen et al.	1	1	3	Showing that the adoption dynamics of free beta products in a co-creation community follow a Gompertz rather than a Bass model	BE: valuable offerings for end users	Product adoption	Co-creation community
Suh and Sohn	1	1	3	Providing a framework for understanding core technological competencies and identifying the trends on technological convergence of a business ecosystem	BE: technological change	Patent	Electronics industry, the United States – national
Visnjic et al.	1	1	3	Showing that city leaders treat cities as ecosystems, structured and governed as extended enterprises or platform markets	BE: meeting the city's predefined goals	Ecosystem partner	Cities, Switzerland, the United States, United Kingdom – global
Kapoor and Lee	1	1	3	Exploring how differences in ways in which firms are organised (e.g. alliances or arms-length transactions) w.r.t. complemen-tary activities affect their decision-making to invest in new technologies	BE: technology investment decision (of firm)	Investment decisions	Healthcare industry, the United States – national
Khavul and Barton	1	1	3	Showing that if sustainability enhancing innovations introduced in developing countries are to stick, they should be designed with local customers, networks and business ecosystems in mind	BE: introduction of sustainabili-ty enhancing innovations in developing countries	Ecosystem	Developing countries – national
Lu et al.	1	1	3	Developing a conceptual model of agent-based system for business ecosystem evolution	BE: nurturing emerging industries	Ecosystem partner	Electrical vehicle industry, China – national
Wang et al.	1	4	2	Presenting a two coupled network model as an example of a real-world distributed agent system	–	Ecosystem partner	–
Nishino et al.	1	4	2	Examining cooperation networks in business ecosystems by the use of game theoretic modelling and multi-agent simulation	–	Ecosystem partner	–
Rong et al.	1	1	3	Exploring the relationships that exist between business models and ecosystems	BE: solving market challenges for emerging industries	Business model	3D printing industry, China, the United States, United Kingdom – worldwide
Rong et al.	1	1	3	Developing an integrated framework combining network structural characteristics and	BE: Network effects	Ecosystem partner	Online game market, China – national

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				network functioning characteristics, which are the key determinants of network effects			
Rong et al.	1	1	2;3	Developing the 6C framework to identify three patterns of IoT-based business ecosystems	BE: Sustainable development	Ecosystem partner	IoT-based sectors, China – national
Rong et al.	1	1	3	Developing a framework for nurturing business ecosystems in a foreign market in three sequential stages: incubating complementary partners, identifying leaders and integrating ecosystem partners	BE: Corporate growth in foreign market	Ecosystem partner	MNE, China – national
Rong et al.	1	1	3	Exploring how firms nurture business ecosystems to deal with emerging industry uncertainties	BE: Emerging industry development	Ecosystem partner	Mobile computing industry, China – national
Gomez-Uranga et al.	1	1	3	Introducing the concept of Epigenetic Economic Dynamics and its application to internet industry groups	BE: Sustained profit growth	Patents	Big Internet Industry groups, the United States – national
Graca and Camarinha-Matos	1	3	4	Surveying research fields that offer potentially suitable performance indicators and highlighting their potential contribution concerning the assessment of collaborative benefits and performance	BE: Sustainable economic, social and environmental impact	Performance indicators	–
Kang and Downig	1	1	3	Proposing a dynamic model to map a market landscape that shows the internal and external conditions under which a new platform can enter a two-sided market in a winner-takes-all setting	BE: New platform entry	Financial data (e.g. market share, costs, subscribers)	Global telecommunications market – global
Liu and Rong	1	1	3	Showing that co-evolutionary processes consist of three domains of activity (co-vision, co-design, co-create) and that each of these domains plays a unique role in stimulating collaborative innovation for complex product development	BE: Complex product development	Ecosystem partner	Mobile computing industry, China, United Kingdom, the United States – global
Tellier	1	1	3	Identifying mechanisms (keystone's ability to change the business model and substantial dependence on dominators) that contribute to the decline of ecosystems	BE: Ecosystem survival	Ecosystem evolution	Pinball ecosystem, Chicago, the United States – local
Luo and Triulzi	1	1	3	Showing that a firm's participation in inter-firm transaction cycles is positively and significantly associated with its innovation performance for	BE: Firm performance	Patents and ecosystem structure	Electronics sector, Japan – national

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				vertically integrated firms			
El Sawy et al.	1	1	3	Showing the foundations for enhancing enterprise capabilities for digital leadership and formulating lessons for digital entrepreneur-ship	BE: Digital leadership	Capabilities	International toys company – global
Li	1	1	3	Showing how Cisco's M&A strategy resulted in corporate growth of their business ecosystem via standardisation and a complemen-tary technological portfolio	BE: Corporate growth	Patents	Internet infrastructure market – global
Iansiti and Levien	1	4	1	Proposing three ecosystem strategies (keystone, dominator, niche player) that influence the health of an ecosystem	BE: Firm performance	Ecosystem	–
Kapoor and Argwal	1	1	3	Developing a theoretical framework that explains how structural and evolutionary features of the ecosystem shape to which participating complemen-tary firms can sustain their performance	BE: Sustainable superior firm performance	Financial statistics	Smartphone ecosystems, the United States – national
Adner and Kapoor	2	1	3	Exploring the forces that determine the pace of technology substitution by presenting a framework that identifies how and when a technology is resolved	IE: New technology emergence	Ecosystem partner	Semiconductor lithography equipment industry – global
Mack and Mayer	3	1	3	Developing an evolutionary framework of entrepreneurial ecosystem development that integrates components from previous work and describes its interactions and evolution over time	EE; Entrepreneurship	Ecosystem	Phoenix, the United States – regional
Neck et al.	3	1;2	3	Examining the interaction between the multiple components of the entrepreneurial ecosystem, which collectively influence new venture creation in a region	EE: New venture formation	Ecosystem	Technology start-up clusters, Boulder, the United States – regional
Cohen	3	1	3	Exploring how components of the formal and informal network, physical infrastructure and culture within a community could contribute to sustainable entrepreneurial ecosystem	EE: Social, environmental and economic value	Ecosystem	Community, British Colombia, Canada – local
Spigel	3	1	3	Showing that entrepreneurial ecosystems consist of ten cultural, social and material attributions that interact, resulting in a variety of different ecosystem configurations	EE: High rates of entrepreneurship	Ecosystem	Waterloo and Calgary, Canada – regional

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