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FEATURES OF INNOVATIVE ECOSYSTEMS AND THEIR TYPOLOGY

Kapitanov Egor[1]

[1]*Master of Science in Business Administration, Strategy Track (MBA, Strategy), University of Amsterdam, Amsterdam Business School, Amsterdam, Netherlands*

Abstract

Modern literature reviews devoted *to innovative ecosystems (IE)* or ecosystems in general lack a focus on developing a typology, which is noted by a number of specialists and identified by them as a significant gap in the research. However, the importance of constructing a typology lies in its ability to systematize the identified diversity of innovative ecosystems by grouping them according to certain criteria (attributes), which is an important step in theoretical research. The need for such a step is determined by the logic of the transition from the stage of developing definitions of concepts to their operationalization (measurement), which helps focus further empirical work and is crucial for the systematic accumulation of knowledge on innovative ecosystems. This indicates *the relevance* of the chosen research topic.

In this paper, based on a comprehensive review of the specialized literature, knowledge on innovative ecosystems is expanded and supplemented: (1) the conceptual problem of defining IE is considered, for which a dual approach is proposed - understanding IE in both the narrow and broad sense; (2) a system of key criteria for the typology is determined, correlating with the corresponding types of IE; (3) the author presents a *systemic typology of IEs*, developed using a cumulative approach based on previous research. This typology helps identify relevant attributes characterizing a specific ecosystem. This is important both for identifying each specific object of study and for the further development of ecosystem theory in this area. A number of types absent from the literature were also identified, for example, based on the classification criterion *"sources of funding"* in the field of innovative ecosystems. The presented typology will be useful for a better understanding of ecosystem characteristics during their further study and practical use, as well as for successful strategic management of them in business.

Keywords

Innovative Ecosystems, Collaborative Innovation, Open Innovation, Ecosystem Characteristics, Typological Criteria, Typology

1. Introduction

In this article, we focus on *innovative ecosystems (IEs)*, which are of great significance and broad applicability in both innovation and strategic management. The IE framework is used to develop new businesses and address the survival challenges of mature companies at various levels (local, regional, organizational, and/or functional).

In the past decade, there has been a dynamic increase in the popularity of IE research among scholars (Su et al., 2018; Beliaeva et al., 2019; Kang et al., 2019; Bacon et al., 2020, etc.), accompanied by a "growing interest" among practitioners and even policymakers (Dedehayir et al., 2016, p. 9). Innovative ecosystems are viewed as a dominant concept in innovation management, enabling to manage them in a particularly accurate and timely manner. *The IE-concept* takes into account more progressive

externalization, systemic co-implementation, and networking of innovations (Ritala & Almpanopoulou, 2017, p. 39) typical of the modern business environment.

Innovative ecosystems are credited with exerting a multi-level impact on innovation: they enhance the innovative potential (Pellikka & Ali-Vehmas, 2018) and innovative performance of both the entire ecosystem (Talmar et al., 2018) and its actors (Song, 2016). IEs are ideally suited to the use of various forms of interaction with customers, who are considered their subjects in the new product development process (Autio & Thomas, 2014; Russell & Smorodinskaya, 2018). Some authors even believe that the inclusion of customers among IE subjects is a distinctive feature of innovative ecosystems compared to other types of ecosystems (Valkokari, 2015; Oh et al., 2016; Gomes et al., 2018).

Innovative ecosystems have also become a relevant area of research in strategic management, as they influence company strategy and performance by increasing company profitability, reducing time to market, expanding market access (Pellikka & Ali-Vehmas, 2018), and improving the new product development process (Bouncken et al., 2018).

From a longer-term perspective, participation in an innovative ecosystem brings strategic benefits arising from relationships with other actors through competition, cooperation, or co-opetition. Competitive advantages accrue to those who participate in IEs, as opposed to those who do not. The benefits of collaboration are based on relational rents (Dyer & Singh, 1998) and the social relationships of managers, and are used in relational strategies (Zakrzewska-Bielawska, 2019). They are emphasized to stimulate radical innovation (Bouncken et al., 2018) and business model innovation (Bouncken & Fredrich, 2016). At the same time, co-opetition in IE brings the benefits of both competition and cooperation (Bacon et al., 2020) and is generally more beneficial than those relationships based on "pure competition" or "pure cooperation" (Ritala et al., 2013, 2016; Gawer & Cusumano, 2014; Bouncken et al., 2015).

Finally, Beliaeva et al. (2019), Granstrand and Holgersson (2020) also believe that IEs, compared to other ecosystem types, are the most strategically oriented. For example, the latest results of a literature review show that four out of six requests to AI, concerning innovative ecosystems, are directly related to the strategic context (i.e., related to ecosystem strategies - innovative or governance/orchestration) (Yaghmaie & Vanhaverbeke, 2019).

Since the turn of the century, the concept of IE has been fruitfully applied in various contexts and in various ways. However, its popularity across various research fields is complicated by its ambiguity, as various "definitions" of the term are used (Wei et al., 2020). The existing differences in these definitions, by introducing confusion, hinder dialogue among specialists and thereby impede the systematic accumulation of empirical data, hence holding back research progress overall (Venkatraman, 1989). Therefore, it is crucial to develop rigorous scientific definitions of concepts that allow researchers to speak a common language and reach a consensus on their essence (Kang et al., 2019). Thus, Carayannis & Campbell (2009) note that there is "an overlap in the concept of IE with similar concepts" of other organizational and economic forms of doing business, such as networks, chains or clusters, which is not surprising given the lack of a generally accepted definition of "ecosystem" and IE in particular. Nag et al. (2007) note that generally accepted definitions are necessary in academic disciplines to preserve their distinctiveness and collective identity, but the process of their development is complex due to the essentially polymorphic nature of ecosystems (Valkokari, 2015; Aarikka-Stenroos & Ritala, 2017; Scaringella & Radziwon, 2018; Tsujimoto et al., 2018), leading to "overlaps between different types of ecosystems", which, we note, is also not surprising given the lack of a correctly constructed typology.

Nevertheless, in the last decade, research has emerged that aims to address the two issues noted above: (1) constructing a generally accepted definition of innovative ecosystem and (2) developing a typology of IE (Rabelo & Bernus, 2015; Valkokari, 2015, Granstrand & Holgersson, 2020). The former has been addressed, for example, in Granstrand & Holgersson (2020), and the latter in an extensive article by Klimas & Czakon (2022). However, their results show that this is clearly insufficient. The research gap in this area remains unclosed.

In view of the above, the aim of this article is to propose a proper definition of innovative ecosystem and develop an IE-typology useful for further empirical research and management practice.

2. Developing an understanding of the IE-concept. A review of publications in recent years

An analysis of scientific publications from 2010 to 2022, highlighting the most recent research trends, shows that the fundamental aspects of the innovative ecosystem concept have been largely uncovered, that allows to form a general understanding of what is an IE and what is not. Overall, existing *theoretical* studies demonstrate the diversity of notion of IE, creating the impression of multifaceted nature of this concept and enhancing its scientific potential in economic theory. *Empirical* studies demonstrate the diverse of using such ecosystems in practice, linking theory with the practical application of the IE-framework.

Thus, Öberg & Alexander (2018), applying the ecosystem approach, conclude that IEs represent a specific stage in the development of *open innovation theory* (Chesbrough, 2003). By shifting from the transfer of ideas and knowledge within a framework of specific focal firm to the mutual knowledge exchange format among many ecosystem participants, they switch attention to the conditions of ecosystem functioning (Öberg & Alexander, 2018). Bacon, Williams, and Davis propose two approaches to studying IEs: one based on their geographic proximity and the other - on value creation and capture. They pay particular attention to the opportunities that SMEs have when collaborating with ecosystem subjects, as well as knowledge and the characteristics of its transfer within IEs (Bacon et al., 2019).

Xie & Wang (2020) argue that a firm's participation in IEs expands its capabilities. Radziwon & Bogers, studying the difficulties of SMEs functioning within IEs, propose dividing governance and implementing it at three levels: at the level of ecosystem subjects, the relationships between them, and the level of entire ecosystem (Radziwon & Bogers, 2019). Konietzko, Boken, and Hulting believe that IE can serve as a tool for transforming linear economies into circular ones (Konietzko et al., 2020). Also interesting (but in our view, insufficiently substantiated) seems the interpretation of the IE-concept as a synthesis of two ecosystems—the business ecosystem and the knowledge one (Valkokari, 2015).

Finally, one of the more recent interpretations of the IE-concept, resulting from a synthesis of research over 15 years, has come to view on IE as an evolving set of actors and activities, as well as their relationships, that play a significant role in the innovation activity of the focal firm (FF) and the entire ecosystem (Granstrand & Holgersson, 2020).

This review shows that, to a large extent, research is no longer devoted to studying the basic notions and principles of the IE-concept, but to the spectrum of its various interpretations, reflecting its theoretical and practical capabilities. What are the fundamental aspects of the innovative ecosystem concept identified by researchers? Based on a review of publications related to IE, we can identify the following (Table 1).

Table 1. **Fundamental aspects of the IE-concept**

№	Aspects	Description
1	***The central subject*** around which the IE is built (Pellikka & Ali-Vehmas, 2016; Helfat & Raubitschek, 2018; Konietzko et al., 2020)	This is a *focal firm (FF)* or digital platform, business unit, or structural subdivision. It is responsible for the management and sustainable functioning of the IE, and orchestrates the creation of joint results. Depending on the specifics of the IE, it controls access to the platform, as well as the right to use its brand and benefit from its commercialization (Autio & Thomas, 2014). However, Radziwon and Bogers (2019) also allow for the presence of other potential orchestrators.
2	***Various economic agents***	*Subjects from the immediate environment of the FF* plus *indirect participants of the IE*, who can also influence the IE activities (Öberg & Alexander, 2018). The performance of the FF and the IE as a whole depends on the activities of all its economic agents (Adner & Kapoor, 2010), the number of which is determined by the degree of openness of the IE. The IE-concept focuses on *producers*, paying attention to both *suppliers* and *complementors* (producers of complementary goods and services), as well as *consumers* (Autio & Thomas, 2014).

3	***Linkages between IE participants***	The location of IE subjects and the connections between them are crucial for the successful functioning of the entire ecosystem (Adner & Kapoor, 2010). These connections concern the exchange of knowledge, values, and other resources (Ritala & Almpanopoulou, 2017). They are often digitalized (through the use of IT technologies), exist within the paradigm of *"open innovation"*, utilize the differentiation of roles of IE subjects, and are stronger than the influence of market forces (Oh et al., 2016).
4	***The common goal of IE participants***	This is a crucial element for the whole IE, referred to as the *value (focus) proposition of the ecosystem* (Walrave et al., 2018; Konietzko et al., 2020).
5	***Jointly created value***	IE enables its participants to *jointly* create value that would be impossible for them to achieve individually or would require unacceptable costs (Adner, 2006; Pellikka & Ali-Vehmas, 2016; Konietzko et al., 2020).
6	***Interdependence of ecosystem members***	The success/failure of an IE's value proposition is determined by the performance of each of its member individually and the quality of their relationships with each other (Walrave et al., 2018; Radziwon & Bogers, 2019; Konietzko et al., 2020).
7	***Embeddedness of members in IE***	It allows each member to derive personal benefits within the framework of the shared value created by all its participants (Walrave et al., 2018). Moreover, it creates an opportunity for small firms - IE subjects - to become competitive on the global stage (Öberg & Alexander, 2019).
8	***Additional resources received by IE subjects***	The ecosystem format allows the focal firm to attract resources from other IE participants, enabling it to expand the boundaries of its capabilities. However, they also have access to various FF resources to improve their financial indicators as well as knowledge (Pellikka & Ali-Vehmas, 2016).
9	***Ecosystem dynamism***	IE - constantly changing structure that responds to new challenges in the competitive environment and new consumer desires, transforming itself under the influence of changing conditions. The dynamism of IE provides opportunities for creating and distributing value (Helfat & Raubitschek, 2018).
10	***Ecosystem benefits***	Increased profitability, reduced time to market for new products, improved innovative capabilities and reduced learning curves, expanded market access, etc. (Pellikka & Ali-Vehmas, 2016).

Source: prepared by the author based on the cited sources.

We would like to add that among the properties of IE identified by researchers, there is nothing so distinctive that was not characteristic of any other ecosystem. It suggests that *the characteristic feature of IE* (that distinguishes this type of ecosystem from other types in the ecosystem universum) has not yet been identified or simply it doesn't exist.

In fairness, we should note, that those works that criticize (both in theoretical and practical aspects) this format should be also included into the review materials concerning constructive and positive studies of the IE-concept. For example, Ritala & Almpanopoulou (2017) believe that this concept is used inconsistently, as well its contribution to science and the applicability of IE-theory in practice is questionable. Adner (2006) warned of the failure of attempts to implement IE in practice, pointing out that, along with enticing opportunities, it (this attempt) is also associated with risks that can offset all potential benefits (Adner, 2006; Oh et al., 2016).

However, despite the noted criticism and identified problems, numerous sources allow us to argue that the emergence of the IE-concept signifies a transition to a new paradigm in management, one with its own philosophy and requiring a different approach to strategic management.

Note several factors that ensure this conclusion concerning IE (Table 2).

Table 2. Factors providing the effective development of IE-concept

№	Factor Title	Description
1	*Innovation*	- the most important one, related to the very essence of the IE-concept; which provides *innovative products* (goods, services, and technologies) to the market. It reflects the permanent transformation of technologies and resources into new products with lower costs, ensures adaptation to the changing environment, and creates new niches (Iansiti & Levien, 2004).
2	*Strategic*	- ensures *the sustainable development* of the IE and its successful implementation of innovations in *the long run*. Determines the quality of processes and the effectiveness of working with partners, as well as *the creation of an innovative strategy* that takes into account the risks inherent in the ecosystem (Adner, 2006).
3	*Infrastructure*	- provides a *culture of innovation*, creating it through *a special infrastructure* (network or cluster), facilitating the occurrence of *synergy effect* in cooperation between a wide variety of participants, such as universities and enterprises (Mercan & Göktas, 2016).
4	*Human*	- is reflected in the availability of talented people; the concentration of researchers, entrepreneurs and various institutions; the presence of an *entrepreneurial culture* that places new demands on IE subjects, which may include businessmen, representatives of science or the state, and also provides access to capital and a favorable environment, taking into account regulatory constraints (Oh et al., 2016).

Source: prepared by the author based on the cited sources.

The above, rather comprehensive understanding of the concept of "innovative ecosystem" as a multifaceted one underlies our perception of IE used in this study.

Overall, the concept of "innovative ecosystem" is a starting point and a tool for solving a variety of specific practical problems, each with its own unique conditions. This is where the diversity of IEs identified by previous studies comes in handy, for which the development of a multi-criteria typology, presented in the second part of the paper, is useful.

3. The problem of identifying the characteristic feature of IE in developing its definition

Innovative ecosystems are generating strong and rapidly growing interest among scholars, practitioners and even policymakers (Tsujimoto et al., 2018; Yaghmaie & Vanhaverbeke, 2019). This has led to a rapid growth in the body of knowledge, including theoretical propositions, conceptual considerations, case studies, and empirical research results. However, as is the case with ecosystems, there is no single, generally accepted definition of IE in the literature. The diversity and abundance of structural approaches, conceptualizations, definitions, operationalizations, or even terms and labels (Oh et al., 2016) is confirmed by existing literature reviews, including *interpretive* (Tsujimoto et al., 2018), *hybrid* (Gomes et al., 2018) and *meta-analytic* (Ferasso et al., 2018) ones. This suggests that current knowledge on IE lacks coherence (Gomes et al., 2018; Granstrand & Holgersson, 2020; Bacon et al., 2020). Full-fledged knowledge on innovative ecosystems is still emerging and remains fragmented (Russell & Smorodinskaya, 2018). Moreover, they remain described as sparse and ambiguous compared to literature, for example, on business ecosystems (Oh et al., 2016). Conceptual rigor and clarity require that IEs be distinguished from related concepts that can be achieved by identifying their key characteristics.

The previous section demonstrated that the development of concepts around the innovative ecosystem has evolved from approaches that analyze the specifics of this concept to efforts to integrate these specifics into a single, generally accepted definition (Walrave et al., 2018; Radziwon & Bogers, 2019). However, economic theory currently lacks a unified understanding of how the concept of an "innovative ecosystem" (IE) emerges and how it differs from other types of ecosystems (Ferasso et al., 2018; Gomes et al., 2018).

It can be said that the literature published to date demonstrates a wide range of interpretations of innovative ecosystems (Granstrand & Holgersson, 2020). Due to the presence of many *terminological* (Oh et al., 2016; Gomes et al., 2018; Yaghmaie & Vanhaverbeke, 2019; Granstrand and Holgersson, 2020) and

methodological inconsistencies (Aarikka-Stenroos & Ritala, 2017; Ritala & Almpanopoulou, 2017), it is important to critically analyze and systematize the current general state of knowledge on IE.

Identifying a characteristic property of IE that could form the basis of its generally accepted definition would make it possible to distinguish IE from other types of ecosystems. And several such differentiation criteria have been proposed in the specialized literature. For example, Rabelo & Bernus (2015, p. 2250) and Autio & Thomas (2014) consider IE as the "most salient type of environment" that goes beyond a single industry or sector and creates a multidimensional, complex context for any entrepreneurial activity (Vasconcelos Gomes et al., 2018), leading to innovation (Beliaeva et al., 2019; Valkokari, 2015). However, such a view does not add anything new to the IE (Adner, 2017, Jacobides et al., 2018), since all ecosystems are a new organizational and economic form of doing business, differing from other forms (network, cluster, virtual, etc.) in their connection with the external environment (Kapitanov, 2025b).

Patrycja Klimas and Wojciech Czakon (2022) also view IE as a ***collaborative environment*** encompassing the innovative activities of its co-evolving actors, believing that ***value co-creation*** can also be used as *a differentiation criterion*. They believe that different *types of value co-creation relationships* form different ecosystems. Thus, business ecosystems are characterized by relationships involving the co-creation of *relevant and competitive business-models*. *Knowledge co-creatio*n relationships are characteristic of *knowledge ecosystems*, where new, original, and *jointly created knowledge* constitutes the value jointly created by participants. ***Venture co-creation*** relationships are characteristic of *entrepreneurial ecosystems* (Beliaeva et al., 2019; Kang et al., 2019). In turn, *innovative ecosystems* co-create value through ***joint innovation.*** That is, the authors suggest that *innovation co-creation relationships* are *a distinctive feature* of the IE-concept, as they enable *participants* and *the entire ecosystem to jointly* ***create value through collaborative innovation*** (Aarikka-Stenroos and Ritala, 2017; Klimas, 2019). However, *value co-creation* is not a separating characteristic here, but a unifying one. *The separating criterion here* is the ***type of output*** within the value proposition (knowledge, new firms, services, innovations, etc.). Vargo (2009) also believes that *value co-creation relationships* are simply *one of the ecosystem relationships aspects*.

These conceptualizations are largely compatible with each other, and the adoption of a particular conceptualization depends on the reference theories underlying the specific aspects of IE examined in a given study (Gomes et al., 2018), meaning they fail to distinguish IE from the ecosystem universum. In other words, the concept of IE is extended to the concept of the ecosystem universum due to the presence of this *level of generality*. Granstrand & Holgersson (2020) also identified *a number of shortcomings* in the existing conceptualizations of previous works.

Expanding the IE-concept beyond *the focal firm*, many authors include innovations of other subjects and ecosystem partners within the boundaries of innovative ecosystems (Song, 2016; Pombo-Juárez et al., 2017; Holgersson et al., 2018; Yaghmaie & Vanhaverbeke, 2019). With the participation of other actors, *value creation activities* become *a process of* ***collaborative innovation***. However, the proposed way of understanding IE is consistent with the definition of *simple* ecosystem given by Adner: *"An alignment structure among a multi-faceted set of partners that need to interact to realize a focal value proposition"* (Adner, 2017, p. 40). Moreover, IE participants engage in both collaborative and competitive relationships *to create innovations* (Holgersson et al., 2018; Talmar et al., 2018; Walrave et al., 2018; Bacon et al., 2020).

Thus, the chaos that exists in the definitions and notations used (Gomes et al., 2018; Wei et al., 2020, p. 5) can be seen as a motivation for paying more attention to the requirements of methodological rigor when identifying *the IE characteristic property* (Ritala & Almpanopoulou, 2017).

Now we turn to the original source. J.F. Moore was the first to use the concept of *a business-ecosystem*, in which organizations "*collaboratively develop their capabilities around a new innovation*: they work cooperatively and competitively to support *new products*, satisfy customer needs, and ultimately incorporate *the next round of innovation*" (Moore, 1993, p. 76). Therefore, the business-ecosystem introduced by Moore already possesses *the property of innovativeness*! That is, in the set-theoretic representation, *the multitude of innovative systems fills the ENTIRE universum of ecosystems*. Subsequently, authors studying this concept built on Moore's ideas (postulates), enriching them with a diverse innovative components (Ritala et al., 2013; Autio & Thomas, 2014; Pellikka & Ali-Vehmas, 2016; Granstrand & Holgersson, 2020; and others).

Moreover, Moore and a number of his followers also considered the *coevolution* of its participants, conditioned by the presence of *interconnections between the subjects* of this ecosystem, to be the main

distinguishing feature of the IE, in contrast to previous innovation concepts (technology parks, science cities, technopolises, innovation clusters, etc.) (Moore, 1993; Walrave et al., 2018; Radziwon & Bogers, 2019). Such *collaboration* ensured competitiveness for each subject in the business ecosystem and helped materialize the value proposition, satisfying customer needs. Recall that Granstrand & Holgersson (2020) proposed to consider such *relationships* as a key component that distinguishes IE from other ecosystems.

Ultimately, we can offer the following dual understanding of IE:

(1) **In a narrow sense*, an innovative ecosystem*** is *a network of interconnected and interdependent* participants that ***come together to create innovative products*** (goods, services, technologies, start-ups, etc.) (Adner & Kapoor, 2010; Helfat & Raubitschek, 2018). Note that *innovative products*, understood broadly, are created on the basis of very specific production and other *innovations*. That is, the definition is quite capacious.

(2) **In a broad sense**, ***any ecosystem should be perceived as an IE*** due to its inherently *innovative nature*. Some scholars have already taken this path, proposing to consider IE as a *meta-ecosystem* consisting of three interconnected layers: *the scientific ecosystem*, *the knowledge ecosystem*, and *the business-ecosystem* (Xu et al., 2018). This more complex view demonstrates the *predominance* of innovative ecosystems *over other ecosystems*, which allows us to classify this concept as more advanced and closer to our point of view.

It is currently clear that within the framework of the second view of innovative ecosystems, the identified diversity of ecosystems requires the development of a comprehensive, multi-criteria *typology*, and we will focus on this below.

4. The IE-diversity in economics and their typologies in the specialized literature

The use of ecosystem concepts and related approaches has generated numerous studies in the literature (Adner, 2017; Tsujimoto et al., 2018; etc.). This development has contributed to the expansion of knowledge, including the emergence and study of various ecosystem types (Pilinkiene & Maciulis, 2014; Valkokari, 2015; Aarikka-Stenroos & Ritala, 2017; Scaringella & Radziwon, 2018;), recognized as *interconnected* (Valkokari, 2015), *interdependent* (Xu et al., 2018) and *overlapping* (Scaringella & Radziwon, 2018).

Conducted analysis of specialists' researches shows that the study of IE has moved beyond the stage of operationalizing concepts and considering specific aspects. New concepts have emerged - more complex *constructs* that require *typification*, both for their identification and comparison of their level within a certain criterion, and for the development of methods for assessing their development depending on their type. The creation of a typology *involves identifying key attributes* of ecosystems and *their features* based on *goals, structure, set of actors, dynamics*, etc.

Our further research aims to fill this gap. In particular, we believe it is relevant to address ***the types*** of innovative ecosystems as they are understood and ***the criteria*** used to group them. Among the gaps and shortcomings discussed in the literature on IEs is the notion that *"no clear typology of innovative ecosystems is provided"*, although "this term is mentioned in several contexts" (Oh et al., 2016, p. 3).

Literature reviews have attempted to identify a number of ecosystems *mini*-typologies, such as:

- *business, industrial, innovative, digital* and *entrepreneurial* ecosystems (Pilinkiene & Maciulis, 2014);
- *business, knowledge* and *innovative* ecosystems (Valkokari, 2015);
- *business, innovative, entrepreneurship, start-up platform* and *service* ecosystems (Aarikka-Stenroos & Ritala, 2017); and
- *business, innovative, entrepreneurship and knowledge* ecosystems (Scaringella & Radziwon, 2018).

Since creating an IE typology involves identifying *key features (attributes)*, it is important to consider another stream of research that additionally identifies demarcation criteria that distinguish IEs from other ecosystems in terms of structure, dynamics, etc. Scholars and practitioners have proposed several approaches to classifying ecosystems based on their characteristic features (Pilinkiene & Maciulis,

2014; Valkokari, 2015; Aarikka-Stenroos & Ritala, 2017; Scaringella & Radziwon, 2018; Vasconcelos Gomes et al., 2018), namely:

- Clarysse et al. (2014) distinguish between *knowledge and innovative* ecosystems using several criteria, namely: ***goals, relationships*** and ***subjects***.
- Pilinkiene & Maciulis (2014) use the ***type of environment, actors, micro- and macro-outcomes,*** and ***key success indicators*** to differentiate *industrial, innovative, business, digital, and entrepreneurial ecosystems.*
- Valkokari (2015) identifies three distinct types of ecosystems: *business, innovative* and *knowledge one*, analyzing their ***goals, internal relationships, levels of interconnectedness among actors, roles assumed by them*** and ***the general logic*** of each ecosystem type as separation criteria.
- Scaringella & Radziwon (2018) differentiate *innovative, business, knowledge and entrepreneurial* ecosystems in terms of ***geographic scope, values, stakeholders, importance*** and ***types of economic and social problems, level of knowledge*** and ***outcomes***.
- Gomes et al. (2018) consider *value creation and capture* to be the key characteristic for distinguishing IEs, and the ***type of actor's orientation*** toward customer requirements to be the most important criterion for distinguishing *business, knowledge* and *innovative* ecosystems.
- Finally, Aarikka-Stenroos & Ritala (2017) point to ***geographic scope, subjects*** and ***related issues*** (e.g., *specific goals, values* and *beliefs* they hold) as a valid approach to distinguishing *between business, innovative, entrepreneurship,* as well *platform ecosystems* and *service ecosystems.*

Note that these studies do not establish a correspondence between a specific criterion and some of the IEs they identify.

Here, it is worth considering in more detail the study by Klimas and Czakon (2022), who attempted to thoroughly address the issue of identifying criteria and typologies of IEs. In total, they identified 14 criteria and 50 types. The authors subsequently combined all the criteria they identified into the following five, without explaining why they did so in this particular order:

(1) life cycle,
(2) structure,
(3) innovative focus within the IE,
(4) scope of application, and
(5) effectiveness.

The authors' rationale for identifying these criteria was based on the following considerations.

The first criterion focuses on how the IE emerges and at what stage of the life cycle it is. *Based on their origin*, IEs can be *classified as intentionally created* or *emergent* (Rabelo & Bernus, 2015; Russell & Smorodinskaya, 2018) or *by the stage of the ecosystem life cycle - emerging, developing, mature, declining (*or *moribund)* (Moore, 1993; Ritala et al., 2013; Dedehayir et al, 2016).

The second criterion is based on *the structural perspective* proposed by Adner (2017). According to this criterion, IEs can be divided into *symmetric* and *asymmetric*, or *centralized* and *decentralized*. If the focus is on *the co-creation of innovations, egocentric* and *ecocentric IEs* can be distinguished (Gomes et al., 2018). The *criterion of governance mechanisms* can also be included here - *orchestration/hierarchy, collective coordination/heterarchy* or *self-coordination* (Rabelo & Bernus, 2015; Oh et al., 2016; Russell & Smorodinskaya, 2018).

The third criterion defines the *main goal of innovative ecosystems* or its leading *innovative focus*. According to this, IEs can be classified according to three typological criteria:

1) *the scale of innovations* adopted in the ecosystem - *microscopic, medioscopic or macroscopic* (Su et al., 2018);
2) *the type of innovation* that IE subjects typically focus on – *disruptive innovation, radical, incremental or social innovation,* and *pioneering innovation* (Aarikka-Stenroos & Ritala, 2017; Adner & Kapoor, 2016; Walrave et al., 2018);
3) *the intensity of collaboration* in the co-innovation process – benefiting only *from co-discovery*, from *co-development*, from *co-deployment*, from *co-delivery*, and only from *dissemination*, or

benefiting from collaboration across several or all stages of the innovation process (Autio & Thomas, 2014; Song, 2016; Klimas, 2019).

The fourth criterion in the typology of these authors concerns *the scope of IE activity - technological, spatial or physical*. From *a technology perspective* the differentiates IEs based on either the classification of the underlying industry using OECD guidelines, i.e. *high-tech, medium-tech* and *low-tech* IEs (Ritala et al., 2013; Rocha et al., 2019), or the *number of underlying technology platforms*, i.e. *single-* or *multi-platform* (Gomes et al., 2018; Su et al., 2018; Vasconcelos Gomes et al., 2018). This distinction stems from the fact that an IE may operate on a single industry-wide platform or on multiple company-specific platforms (Gawer & Cusumano, 2014).

In terms of *spatial scope*, understood as the *geographical range* of both IE activities and products, innovative ecosystems can be divided into *urban/area-based, local, regional, national, international* and *global* (Oh et al., 2016; Xu et al., 2018). These distinctions imply further differences in the level of *horizontal, vertical, temporal* and *intersystem coordination* in IE (Pombo-Juárez et al., 2017).

Finally, based on *the physical scope criterion*, IEs can be divided into *digital* (operating only in cyberspace) and those operating in *both the virtual* and *real worlds* (Gomes et al., 2018; Rocha et al., 2019). This distinction is often referred to as "bricks and clicks." These cases demonstrate how IEs exploit *the dynamics of digital entrepreneurship* (Beliaeva et al., 2019).

The last *(fifth) typological criterion* concerns the effectiveness of IEs. Considering the *type of effectiveness*, IEs can be differentiated as follows:

(1) *by innovative effectiveness* - into *successful/strong*, *unsuccessful/weak*, and *promising* (Mercan & Göktaş, 2016; Xu et al., 2018);

(2) *by economic effectiveness* – into *profitable/healthy* or *unprofitable/unhealthy* (Autio & Thomas, 2014); and

(3) *by strategic effectiveness* – into *sustainable* or *unsustainable* (Wu et al., 2018).

The authors note that the types of IE identified within each criterion are not alternatives, as it is possible, and sometimes necessary, to classify a specific IE by several criteria simultaneously, a point with which we fully agree. Indeed, the same IE can be viewed as *regional* when studying its *spatial scope*, as *centralized* (with the strategic dominance of a single subject), when discussing its *emergence*, as *intentional*, and when considering the *nature of collaborative innovation* as *egocentric*. Therefore, when classifying an IE as a particular type of ecosystem in the typology, it is recommended to apply *all criteria*, as this allows the researcher to form a vivid and comprehensive picture of the IE under study.

Regarding the criteria proposed by Klimas & Czakon (2022), we note that their selection is not systemic, that is

(1) The set of criteria is not exhaustive,
(2) Not all of them are independent,
(3) The criteria themselves are not ranked in order of importance.

Furthermore, it should be noted that *the second criterion - the structural perspective* - by dividing IEs by their structure into *symmetrical* and *asymmetrical*, undermines the *governance nature* criterion, within which *centralized* and *decentralized* IEs should be considered.

The third criterion, determining *the primary goal* of an IE, should be linked to *the nature of its activities*, and *the scale* and *innovation type* should be attributed to the criterion of *the nature of innovation*. *The collaboration intensity*, which is not the most important characteristic of an IE, should also not be attributed to the primary goal, as should the criterion of *the origin* of an IE (*whether intentionally created* or *emergent*).

Finally, *the fourth criterion* - the IE's *sphere of activity* - contains activity types - *technological, spatial* or *physical*. Among these, "*spatial activity"* is clearly out of logic, and its characteristics should be considered based on the criterion of *geographic coverage* or *scalability*. Furthermore, *high-tech, medium-tech* and *low-tech* IEs, as well as *the number of basic technological platforms* (*mono- or multi-platform* IEs), should be considered not within the framework of the technological sphere of activity criterion, but rather based on the criterion of the *level of ICT use*.

Thus, Klimas and Czakon (2022), by reducing the number of criteria from 14 to 5, did not clarify the situation regarding the creation of *a system of criteria* for the formation of the IE typology, but only confused it.

It is also worth noting the problem of forming the list of IE types. Returning to the publication by Klimas and Czakon (2022), we will consider the issue of identifying different "types" of IE. Their analysis of literature reviews revealed 34 different *types* of innovative ecosystems, to which the authors added another 16, resulting in a total of 50 IE-types, which creates a somewhat strange impression in the list without specifying criteria.

A duplication of "types" is noticeable (Klimas & Czakon, 2022, p. 268). For example, when describe *the stages* of ecosystem life cycles *"developing"* appears twice. Words *"declining"* and *"death"* cannot describe *different stages* of ecosystem life because they perceived as synonyms. The same remark applies to "*successful" (strong)* and "*profitable"* IEs, respectively. Apparently, *"successful"* IEs are not always *"profitable"* according to the authors' logic. Also, in their added list of 14 "types", there are such "types" as "*unsuccessful" (weak)* and "*unprofitable"*.

Meanwhile, the "*bricks and clicks*" type exists in the list, but in principle, it cannot be a *one* type of IE, as the former ("bricks") operate in the *real world*, while the latter one ("clicks") operate in *cyberspace (digital)* (Gomes et al., 2018; Rocha et al., 2019). Of course, 50 is a nice round number, but in this case it means the loss of quality of analysis due to the lack of logic.

5. Author's system of criteria

The set of *IE differentiation criteria* discussed above is quite broad and unsystematic. Since it's impossible to encompass everything, we'll highlight those we consider most important for practitioners, particularly strategic managers. These criteria and their corresponding typologies will help better analyze and understand the diverse structures and dynamics of IEs, as well as manage them more effectively.

Below are *the key attributes we identified*, used to formulate IE typologies, along with examples from authoritative sources.

(1) ***A focus on value creation*** defines ***the overall logic and purpose*** of each ecosystem type and helps distinguish *ecosystem kind within this attribute*, revealing the ecosystem's specificity in creating a particular *kind of product*. Criterion (1.1) complements criterion (1), which we identified as the *primary* one (see Table 3).

(2) The criterion "***Structure determined by the use of ICT****" is* supplemented by criterion (2.1) "***Level of ICT usage****"*. Criterion (2) is also very important for the manager, as it defines the *"management mechanism"*, which we identified as the next criterion 3.

(3) The ecosystem's ***management mechanism*** is determined by its *structure* and *environment type*, sets *micro- and macro-results and key success indicators*, and allows to distinguish *centralized* ecosystems from *self-organizing* ones.

(4) ***The composition of participants*** determines *the internal relationships* and *levels of interconnection* between subjects, as well as *their roles*. In particular, for some types of IEs, the role of the *government, academia* and *the private sector* (for example, in the development of start-ups) is emphasized.

(5) ***Scale and geography*** reflect *the geographical scope*, distinguishing *local* and *global* ecosystems, as well as the *types of stakeholders* and *the kinds of economic and social problems* they address. Note that the *"scale level"* criterion *extends the ecosystem logic* to the scale of cities, regions and countries (city-level innovative ecosystems, regional or national IEs), which broadens the scope of *the ecosystem concept*. The focus of the "*ecosystem lens*" (as Adner (2017) puts it) shifts from studying individual firms and industries to the innovative development of entire territories, which is gaining practical significance.

The author's list of criteria presented here also includes *second-order criteria*, which allow to find solutions of specific management problems. These are: *(6)* Ecosystem ***Life Cycle Stage***, ***(7) Funding Sources***, and *(8)* ***Effectiveness Type***, - which complement the basic characteristics of IE (reflected in points 1-5 of Table 3).

6. Author's IE typology

Below is the author's *typology of ecosystems* (that is, innovative systems in the broad sense), using the *main criteria* for its formation, in which one or another aspect related to a specific criterion or kind of ecosystem was examined (Table 3).

Table 3. Typology of ecosystems

№	Classification criterion	Kinds of ecosystems and their description
1	***Purpose of functioning*** *(focus on creating value proposition)* (Thomas & Autio, 2020)	- ***business*** *ecosystems* - *goal:* providing existing goods or services through coordination of participants' efforts (Valkokari, 2015; Gomes et al., 2018; Granstrand & Holgersson, 2020); - ***innovative*** *ecosystems* (in the narrow sense) - *goal*: joint creation of value (*new* goods or services) (Adner & Kapoor, 2010; Pellikka & Ali-Vehmas, 2016); - ***knowledge*** *ecosystems* - *goal:* to generate and disseminate knowledge among participants of the ecosystem and beyond (Valkokari, 2015); - ***entrepreneurial*** *ecosystems* - *goal:* creation of new businesses (Mohammadi & Karimi, 2022).
1.1	***Kind of focus product*** (Bacon et al., 2019)	The ecosystem produces: - ***innovative goods,*** - ***innovative services*** - service ecosystems (Vargo et al., 2020), - ***transfers knowledge, technology, connections and information,*** - ***sale of other assets*** (Xie & Wang, 2020)
2	***Structure determined by the ICT use*** (Adner & Kapoor, 2015; Klimas & Czakon, 2022)	- ***platform (digital)*** *ecosystems* - built around *a central platform* that facilitates interaction between ecosystem subjects. There may be one or several platforms (*mono*- and *multi-platform IE*) (e.g., Apple with iOS) (Helfat & Raubitschek, 2018), - ***decentralized (non-platform)*** *ecosystems* - do not have a central coordinator, and interaction between participants occurs organically
2.1	***Level of ICT usage*** (Ritala et al., 2013; Rocha et al., 2019)	- ***high-tech IE,*** - ***medium-tech,*** - ***low-tech***
3	***Management mechanism*** (Rabelo & Bernus, 2015; Oh et al., 2016)	- ***orchestrated*** *ecosystems* - *(hierarchical)* are managed by *a central player* who sets standards and coordinates activities (e.g., Amazon Marketplace) (Wen et al., 2022); - ***collective coordination*** - *corporate ecosystems* are led by large corporations that collaborate with smaller companies and stakeholders (Russell & Smorodinskaya, 2018)**;** - ***self-organizing*** *ecosystems* - interaction between participants occurs without centralized control
4	***Composition (set) of participants*** (Kapitanov, 2025a)	***Direct subjects of IE:*** - *central (focal) manufacturing company,* - *suppliers,* - *complementors,* - *customers (buyers).* ***Indirect participants in IE*** may include**:** - large corporations, - small and medium-sized enterprises (Bouncken et al., 2015; Kraus et al., 2020), - start-ups (Kaurova &Tolstel, 2015), - universities (university ecosystem) (Sergeeva, 2019; Sukhinov & Ugnich, 2017), - local administration, - the state, etc.
5	***Geographic coverage*** *(scale level)* (Ritala &	- ***local*** (urban/rural ecosystems) - limited to a specific region and focused on local interactions (Polbitsyn, 2019),

	Almpanopoulou, 2017)	- ***regional*** - their activities are limited to the region (Solodilova et al., 2018), - ***national*** - operates within a single country, - ***global*** *ecosystems* - span different countries, including many international participants (e.g., global financial networks)
6	***Stage of the ecosystem life cycle*** (Moore, 1993; Ritala et al., 2013)	- *emerging IE,* - *developing,* - *mature,* - *fading / dying* (Dedehayir et al., 2016)
7	***Sources of funding*** (Kapitanov, 2025a)	- *own funds of IE subjects,* - *government investments,* - *investment funds,* - *crowdsourcing,* - *venture ecosystems* (Kaurova &Tolstel, 2015), ets.
8	***Effectiveness type*** (Klimas & Czakon, 2022)	***Innovation effectiveness*** (Mercan & Göktaş, 2016; Xu et al., 2018): - *successful/strong,* - *unsuccessful/weak;* ***Economic effectiveness*** (Autio & Thomas, 2014): - *profitable/healthy,* - *unprofitable/unhealthy;* ***Strategic effectiveness*** (Wu et al., 2018)*:* - *sustainable IE*; - *unsustainable*

Source: prepared by the author based on an analysis of the cited papers.

It should be noted that the considerations regarding IE-types detailed in this study are not exhaustive, as other criteria reflecting newly identified *additional IE characteristics* may be developed.

Nevertheless, the author hopes that the typology of innovative ecosystems presented here will make a clear scientific and practical contribution to the study and development of ecosystem theory.

7. Conclusions

Klimas and Czakon (2022) noted in their study that none of the literature reviews they considered, either on *innovative ecosystems* or ecosystems in general, specifically focused on developing a typology of IE, which they identified as a significant research gap. They indicated the need for further detail, segmentation and differentiation of innovative ecosystems. For example, in their review *a lack of research on the characteristics of IE* was identified (Gomes et al., 2018; Su et al., 2018), as well as *on their distinctive features* (Oh et al., 2016; Scaringella & Radziwon, 2018; Valkokari, 2015). Besides, it was argued that a number of *methodological shortcomings in conceptual works* led to a selective and too narrow approach to theoretical considerations (Oh et al., 2016; Ritala & Almpanopooulou, 2017; Aarikka-Stenroos & Ritala, 2017). The papers that considered *the types* of IE did so selectively and in isolation from the results of the other studies. Many kinds of IE, their characteristics and ways of aggregating into specific types were not considered at all. For instance, Oh et al. (2016) showed that there are many vague, fragmentarily recognized and not fully understood aspects related to IE. The identified diversity does not meet the requirements of logic of forming theoretical frameworks and, therefore, does not contribute to the creation of cumulative knowledge. In this, we fully agree with Klimas & Czakon (2022).

This study *expands and complements knowledge on innovative ecosystems*. It

(1) *addresses the conceptual problem of defining* IE by proposing *a dual approach* to its definition - understanding IE in both narrow and broad senses;

(2) *identifies a system of typology key criteria* and correlates them with corresponding IE *types*;

(3) *presents the author's typology of IE*, which was developed using a *cumulative approach*, building on previous research. This typology helps identify relevant attributes characterizing a specific ecosystem, while recognizing IE as complex and multidimensional (Vasconcelos Gomes et al., 2018; Bacon et al., 2019; Wei et al., 2020). Moreover, a *number of types* absent from the literature were identified, for example, based on the criterion of *the method of financing IE activities ("Sources of funding")*.

The importance of constructing a typology also lies in its ability to systematize the identified diversity of IEs by grouping them according to specific criteria (attributes) (Venkatraman, 1989; Nag et al., 2007). It is the next necessary step in *theoretical* research - in the transition from the conceptualization of constructs (developing definitions of concepts) to the operationalization (measurement) of concepts. It also helps focus further *empirical* work and is crucial for the systematic accumulation of knowledge about IEs. This significantly addresses a research gap in the existing literature.

Thus, *the scientific novelty* of the study has both theoretical and applied (managerial) aspects. The contribution *to ecosystem theory* is the first proposed *typology of innovative ecosystems*, which brings together some disparate findings on this topic and proposes *new* classification criteria that integrate various types of ecosystems into *a systemic typology*. This is important both for identifying each specific object of study and for the further development of ecosystem theory in this area.

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