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Dynamics of actors in innovation ecosystems' analytical structures

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Abstract

Purpose – The link between theory and practice in innovation studies still has some gaps, despite scholars' efforts to illustrate and identify them in real-world situations. To fully understand the dynamics of the innovation ecosystem, it is crucial to consider key actors and their roles and recognize their impact on ecosystem outcomes. Therefore, this paper seeks to discuss how analytical structures of innovation ecosystems address the dynamics of actors and their contribution to the ecosystem outcomes.
Design/methodology/approach – A research protocol was developed to query the Web of Science database to identify analytical structures of innovation ecosystems based on pre-established criteria.
Findings – The dynamics of actors interfere with their contribution to value creation. That is, the actor changes his contribution. Therefore, depending on the ecosystem's value proposition, the activities and dynamics of the actors change over time.
Originality/value – It contributes to advancing the discussion of innovation ecosystems, addressing insights into the dynamics of actors in different analytical structures. The essay proposal considers innovation ecosystems' evolutionary aspects, value propositions and exchange. In addition, the importance of orchestration in the various stages of the ecosystem is highlighted.

Keywords Innovation ecosystem, Analytical structures, Actors dynamics, Proposition
Paper type Conceptual paper

1. Introduction

Innovation ecosystems have emerged as an endogenous strategy for companies to enhance their competitiveness (Adner, 2017; Autio & Thomas, 2022; Baldwin, Bogers, Kapoor, & West, 2024).

Erratum: It has come to the attention of the publisher that the article, Coletto, C., Caliari, L., Bernardes-de-Souza, D. and Callegaro-de-Menezes, D. (2024), "Dynamics of actors in innovation ecosystems' analytical structures", *Innovation & Management Review*, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/INMR-11-2022-0150, was published without including the article's associate editor, Leonardo Gomes. This error was introduced in the production process and has now been corrected in the online version. The publisher sincerely apologises for this error and for any inconvenience caused.

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Conceptually, it involves a collaborative arrangement in which companies combine their offerings into a solution to meet customer needs (Adner, 2006) through complementarities and interdependencies (Kapoor, 2018; Borner, Berends, Deken, & Feldberg, 2023; Jacobides, Cennamo, & Gawer, 2024). This definition has been the focus of a number of articles published in management, innovation, and strategy journals. It contributed to the theme dissemination (Adner, 2017; Dedehayir, Mäkinen, & Ortt, 2018; Jacobides, Cennamo, & Gawer, 2018; Granstrand & Holgersson, 2020; Thomas & Autio, 2020; Gomes, Flechas, Facin, & Borini, 2021; Autio & Thomas, 2022; Cobben, Ooms, Roijakkers, & Radziwon, 2022; Fischer, Gomes, Bernardes, & Facin, 2022; Carst & Hu, 2023).

The crucial topics that have been highlighted in these discussions each holding immense significance are as follow:

(1) The structure and elements of innovation ecosystems (Adner, 2017; Granstrand & Holgersson, 2020; Klimas & Czakon, 2022; Carst & Hu, 2023),

(2) The evolution of ecosystem management and its concept from a historical perspective (Aarikka-Stenroos & Ritala, 2017; Hakala, O'Shea, Farny, & Luoto, 2020; Gomes *et al.*, 2021),

(3) The roles played by actors during the emergence of innovation ecosystems (Dedehayir *et al.*, 2018; Pushpananthan & Elmquist, 2022; Thomas, Autio, & Gann, 2022), and

(4) Identifying research opportunities in this field (Suominen, Seppanen, & Dedehayir, 2019; Fischer *et al.*, 2022; Baldwin *et al.*, 2024).

The field of ecosystems has been widely studied, but it has been criticized for being fragmented and lacking conceptual alignment, which has prevented it from becoming a unified theory (Phillips & Ritala, 2019; Gomes *et al.*, 2021; Autio, 2022; Autio & Thomas, 2022; Carst & Hu, 2023; Baldwin *et al.*, 2024). The current knowledge about innovation ecosystems is insufficient to definitively answer essential questions, such as understanding the key actors involved in their configuration (Fischer *et al.*, 2022), and the specific roles of actors within the value structure (Dedehayir *et al.*, 2018; Carst & Hu, 2023). It is vital to integrate critical actors and functions within the innovation ecosystem to understand the dynamics of the actors and their contribution to the ecosystem's outcomes. However, recent studies indicate that more in-depth research on ecosystem dynamics is still needed (Thomas & Ritala, 2022; Paasi, Wiman, Apilo, & Valkokari, 2023; Carst & Hu, 2023; Baldwin *et al.*, 2024).

The need to further explore the boundary between theory and practice in innovation ecosystems studies is well recognized (Talmar, Walrave, Podoynitsyna, Holmström, & Romme, 2020). Scholars have been working on methods to represent innovation ecosystems in the early stages, developing analytical frameworks that consider the concept of "ecosystems-as-structure" (Adner, 2017). This theoretical essay aims to address the question: How do analytical structures of innovation ecosystems address the dynamics of actors and their contribution to the ecosystem's outcome? Therefore, this paper seeks to discuss how analytical structures of innovation ecosystems address the dynamics of actors and their contribution to the ecosystem's outcome.

This study presents a novel approach to theory and practice by delving into the behavior of actors within frameworks and devising strategies for value co-creation. The essay underscores the necessity to perceive and dissect innovation ecosystems as dynamic elements, grasping their evolutionary aspect that, in turn, influence the ecosystem's outcomes. Furthermore, it will illuminate their role in ecosystem outcomes, draw parallels between analytical structures and propose a theoretical proposition that propels the discourse on ecosystems as a theory.

2. Methodology

The authors used the Web of Science to search for papers published between 2017 and 2022 to identify analytical structures. They chose this database because it provides relevant

metadata such as abstracts, authors, institutions, number of citations, cited references, and impact factors. The selected period was based on articles referencing the ecosystem-as-structure approach, an idea established by Adner (2017). Subsequently, systematic reviews and cutting-edge studies revealed a growing academic interest in ecosystem actors after 2017, as evidenced by an increasing number of publications (Gomes *et al.*, 2021; Carst & Hu, 2023; Daymond, Knight, Rumyantseva, & Maguire, 2023).

The search focused on finding articles that included the terms "innovation ecosystem" and "strategy" in any part of the research (such as title, abstract, keywords, etc.), with the condition that the term "Ecosystem" must be present in the article title. The term "Strategy" was chosen because the ecosystem-as-structure approach highlights the ecosystem as a method of organizing economic activities to achieve competitive advantage and value co-creation. This approach views the ecosystem as a value co-creation strategy, as indicated in studies that follow this approach (Adner, 2017; Jacobides *et al.*, 2018; Kapoor, 2018; Gomes *et al.*, 2021).

The authors applied filters to include documents published in the research fields of "Business" or "Operations Research & Management Science". They chose these fields to align with systematic literature reviews, focusing on high-impact articles on innovation ecosystems in those areas (Gomes *et al.*, 2021; Carst & Hu, 2023; Daymond *et al.*, 2023).

We initially found 249 contributions and reviewed their titles, keywords, and abstracts. We then selected only articles published in Q1 journals and excluded editorials, reviews, and other types of publications. Additionally, within the sample, we identified and removed articles related to business ecosystems, entrepreneurial ecosystems, platform ecosystems, knowledge ecosystems, regional innovation ecosystems, and other related topics. Instead, we focused on selecting articles that contribute to our understanding of innovation ecosystems, as outlined by Adner (2017). The search filters used also form the basis of the theoretical background for our paper.

Afterward, we had twelve articles left. We read all of them to establish further limitations and find the ones that suggested analytical structures for innovation ecosystems. While reviewing articles on intellectual property mapping, we came across topics such as B2B ecosystem management, comparisons between ecosystem-as-structures and ecosystem-as-coevolution, and ecosystem competitiveness. However, these topics did not match the focus of the essay. In the end, we were left with seven articles, one of which was by Adner (2017). The authors did not use this article for comparison because it laid the groundwork for the other analytical structures. We also found articles by Walrave, Talmar, Podoynitsyna, Romme, and Verbong (2018) and Talmar *et al.* (2020) which had the same authors. We chose the more recent one as it builds upon the earlier work and proposes a practical structure for analyzing innovation ecosystems.

For this essay, the following five analytical structures proposed in the literature were used according to this protocol: (1) The model by Granstrand and Holgersson (2020), (2) The "Pie Model" by Talmar *et al.* (2020), (3) The conceptual structure by Benitez, Ayala, and Frank (2020), (4) The attributes of an ecosystem by Gomes *et al.* (2021), and (5) An analysis structure for the emergence and roles of innovation ecosystems by Dedehayir, Mäkinen, and Ortt (2022).

3. Innovation ecosystems

Innovation ecosystems have become increasingly important in company strategies. They emphasize creating of value or innovations through a group of independent but interdependent actors, leading to a system-level outcome (Adner, 2017; Jacobides *et al.*, 2018; Thomas & Autio, 2020; Autio & Thomas, 2022). Ecosystems enable companies to generate value that none of them could achieve alone (Adner, 2006), and they also focus on models for creating and capturing value (Adner, 2017; Gomes, Facin, Salerno, & Ikenami, 2018; Hannah & Eisenhardt, 2018; Hakala *et al.*, 2020; Talmar *et al.*, 2020; Pushpananthan & Elmquist, 2022).

Innovation ecosystems rely on strong interdependence in their structure, architectures, and technological platforms (Jacobides *et al.*, 2018; Autio & Thomas, 2022). These interdependencies affect the ability of actors to create value (Adner & Feiler, 2019), and can be technological, economic, or cognitive. Additionally, innovation activities in an ecosystem demonstrate the co-evolution of actors (Ritala & Almpanopoulou, 2017; Benitez *et al.*, 2020; Gomes *et al.*, 2021), with complementarities being central to ecosystems (Teece, 2018; Carst & Hu, 2023; Baldwin *et al.*, 2024; Jacobides *et al.*, 2024).

Therefore, this study considers innovation ecosystems as structures made up of actors, activities, roles, and connections. These elements need to be aligned in order to provide a central value proposition for customers (Adner, 2017; Walrave *et al.*, 2018; Fischer *et al.*, 2022). Following the ecosystem-as-structure approach, the next section describes analytical structures that aim to represent innovation ecosystems.

3.1 Analytical structures of innovation ecosystem

This section discusses the five analytical structures of innovation ecosystems mentioned. Supplementary File 1 details the structures related to the objective and the main results obtained.

As for the objective, each of the analytical structures proposed by Granstrand and Holgersson (2020), Gomes *et al.* (2021), and Dedehayir *et al.* (2022) has made significant contributions to the conceptual development of the term "innovation ecosystem." For example, Granstrand and Holgersson's work analyzes existing conceptualizations to propose a general definition, while Gomes *et al.* focus on the necessary and unnecessary attributes of an innovation ecosystem. On the other hand, Dedehayir *et al.*'s research details the process of ecosystem emergence and the changes in actors' roles, providing valuable insights. The articles by Benitez *et al.* (2020) and by Talmar *et al.* (2020) present applied structures. Benitez *et al.* proposed a general structure for addressing ecosystems based on their level of development, while Talmar *et al.* introduced a mapping tool. Additionally, both articles discuss the presence of actors in all analytical structures, as well as their interdependencies and complementarities with the ecosystem.

Regarding results and application, the model proposed by Granstrand and Holgersson (2020) has been empirically validated through three well-known cases: (1) innovation ecosystems in videocassettes, (2) mobile telecommunications, and (3) the Apple ecosystem. Talmar *et al.* (2020) applied the Pie Model to study over 260 innovation ecosystems with diverse profiles and contexts, including a new renewable energy storage process developed at a Dutch university. Benitez *et al.* (2020) studied how an innovation ecosystem in Industry 4.0 evolves and consolidates and how value is co-created to provide market solutions from a technology supply perspective. Gomes *et al.* (2021) did not utilize the suggested attributes but instead focused on conducting a systematic review and providing a conceptual definition of "ecosystem management." On the other hand, Dedehayir *et al.* (2022) used the innovation ecosystem of the drug "Herceptin" – the first monoclonal antibody for women with breast cancer - as a case study to discuss the proposed model.

3.2 Actors and coevolution in innovation ecosystems

Subject matter experts initially conceptualized innovation ecosystems as a network of interconnected and interdependent actors. These actors include the focal company, component suppliers (upstream), and complementary product suppliers (downstream) that contribute to the customer value proposition (Ganco, Kapoor, & Lee, 2020; Gomes *et al.*, 2021; Autio & Thomas, 2022; Dedehayir *et al.*, 2022; Carst & Hu, 2023). Supporting this idea, a systematic review by Granstrand and Holgersson (2020) found that although different conceptualizations of innovation ecosystems all focus on actors and their collaborative relationships.

As organizations rely more on partners to contribute to a joint effort, the success of the collective endeavor depends on the successful execution by an increasing number of individual partners (Adner & Feiler, 2019). Ecosystems requires suppliers of complementary products, services, and innovations, which can come from different companies with significant interdependence but without the need for contractual ties (Jacobides *et al.*, 2018; Autio & Thomas, 2022). Complementors are actors whose result increases the value of a main product or service when consumed together, and this integration is (normally) conducted by the customer (Adner & Kapoor, 2010; Kapoor, 2018; Borner *et al.*, 2023; Carst & Hu, 2023). The actors face cooperation and competition in the innovation ecosystem that follows a coevolutionary process (Gomes *et al.*, 2018).

Coevolution is a process that involves collaborative interactions in symbiotic relationships. While connections and dynamics in social systems are not unique to ecosystems, the literature emphasizes actors and the environment in which they operate (Hakala *et al.*, 2020). Usually, research on coevolution in innovation ecosystems is seen as distinct from the structuralism view. Recent studies have highlighted the differences between these two research approaches and emphasized the importance of integrating their theoretical assumptions (Hou & Shi, 2021; Paasi *et al.*, 2023).

All members of an ecosystem benefit from sharing complementary technological resources and capabilities, which helps promote sustainable innovation performance (Hieu, 2021; Pushpananthan & Elmquist, 2022). In other words, they intend to coevolve based on a shared value proposition. As a result, the literature on innovation ecosystems has expanded beyond an exclusive focus on the value of the focal firm while acknowledging the significant role of an orchestrator, particularly during the ecosystem emergence (Autio, 2022; Autio & Thomas, 2022; Klimas & Czakon, 2022).

In an ecosystem, each actor has different goals, perspectives, and circumstances, but they all aim to work together to create value (Adner, 2006; Adner & Kapoor, 2010; Kapoor, 2018; Dedehayir *et al.*, 2022; Baldwin *et al.*, 2024). The actors' contributions to the ecosystem vary in importance, and the ecosystem's structure requires actors to adapt their contributions to the ecosystem's value proposition. This helps manage investments on the contributing actor's behalf (Talmar *et al.*, 2020). The concept of ecosystems-as-structure helps us understand the internal dynamics of the entities involved. It allows us to observe how the roles of these entities evolve (Adner, 2017), with certain entities shifting from central roles during the inception and establishment of the ecosystem to more supportive roles during the leadership phase (Dedehayir *et al.*, 2022; Thomas *et al.*, 2022; Benitez *et al.*, 2020). This evolution is influenced by the interdependencies and coevolution of relevant organizational and institutional entities (Dedehayir *et al.*, 2022; Thomas *et al.*, 2022; Phillips & Ritala, 2019).

The way companies in an innovation ecosystem depend on each other shapes their innovation. Downstream companies benefit from the components produced by upstream companies, while upstream companies are helped by optimizing their search for key components (Ganco *et al.*, 2020). This structure can be self-organized or managed through networks of actors with distinctive characteristics to enable innovative products and services (Benitez *et al.*, 2020). The variety of actors in this ecosystem creates bonds and synergy through interactions and support, resulting in superior value compared to those without such interconnections (Adner, 2017; Kapoor, 2018; Borner *et al.*, 2023; Carst & Hu, 2023; Baldwin *et al.*, 2024).

4. Dynamics of the actors in the analytical structures

The presented analytical structures understand the relevance of value co-creation and bring their arguments about the dynamics of the actors within the ecosystem. In Supplementary File 2, we seek to present the relationships between the dynamics of the actors and co-creation in the analytical structures.

4.1 Analytical structure of Granstrand and Holgersson (2020)

The theoretical model by Granstrand and Holgersson (2020) underscores the role of actors in creating value through complementary and substitute relationships. This model is a direct response to the conceptual gaps that have been identified in previous literature, providing a comprehensive definition of innovation ecosystems. While it does not explicitly outline the actors or their specific roles within the ecosystem, it does emphasize that an innovation ecosystem is a dynamic system of actors involved in collaborative and competitive interactions, with or without a focal company.

The outcome of ecosystem relationships is demonstrated in the innovative performance of participants. The study examined cases that highlighted the importance of both complementary (collaborative) and substitute (competitive) relationships. Such an examination has offered a more comprehensive definition than other analytical structures. In the cases analyzed, such as the VCR, telecommunications, and Apple, technical compatibility standards and technology sharing were vital in both (1) creating and (2) capturing the value between the parties involved (Granstrand & Holgersson, 2020).

4.2 Analytical structure of Talmar et al. (2020)

The "Pie Model" developed by Talmar *et al.* (2020) focuses on the strategic aspects of ecosystems. It aligns with the findings of Granstrand and Holgersson (2020) by emphasizing the critical connections necessary for the functioning of an innovation ecosystem in terms of creating and capturing value. The logic of the innovation ecosystem relies on the characteristics of the individual actors and the ecosystem network (complementarities) to create a value proposition for the entire ecosystem. It involves integrating the relevant properties of the ecosystem, including interdependence, complementarities, and alignment risks.

Value in an ecosystem is created at the meeting point of supply-side actors (companies and participating organizations) and demand-side actors (users and customers). At the actor level, the understanding of resources used by ecosystem actors is structurally positioned to each other and user segments. Actors must capture value, and to do so, they must be committed to the ecosystem, using it for growth, reputation, efficiency, or accessing additional resources (Adner, 2017; Talmar *et al.*, 2020).

In this situation, the influence of the involved parties depends on their bargaining power and their contribution to the ecosystem. When more or fewer interdependent parties take part in the innovation process, there is a balance between risk and value. If any party is unwilling or unable to contribute, the potential performance of the entire ecosystem will be undermined. This interdependence in ecosystem relationships can postpone the introduction of new products/services until all necessary elements from ecosystem parties are in place (Talmar *et al.*, 2020).

4.3 Analytical structure of Benitez et al. (2020)

Benitez *et al.* (2020) are conducting a comprehensive study on Industry 4.0 ecosystems with the aim of providing practical insights into how value is created, developed, and solidified within them. This study meticulously examines the life cycle of the ecosystem and the interdependence of its structural elements within the business environment. It is in line with the evolutionary perspective on value co-creation (Adner, 2017). The structural viewpoint focuses on the micro level, identifying the actors who need to interact to co-create value. These interactions can lead to the formation of self-organized structures or multilayer networks of actors with different attributes, which can facilitate the development of innovative products and services within the ecosystem (Benitez *et al.*, 2020).

The proposal by Benitez *et al.* (2020), and the theoretical model by Granstrand and Holgersson (2020) both emphasize an evolutionary perspective and argue that the structure

of ecosystems is influenced by platforms and technologies that facilitate relationships between companies. The 4.0 solutions involve a complex digital system that is interconnected with technologies, information systems, and processing technologies. This system requires an elevated level of interdependence among actors concerning complementary skills and technologies.

The analytical structure considers the dynamics of actors within an innovation ecosystem based on the "Theory of Social Exchanges." These elements influence the relationships and value exchanges within the ecosystem. Furthermore, the structural elements necessary to support an innovation ecosystem in Industry 4.0 emphasize the interplay between competition and cooperation, especially with regard to stakeholder involvement (Benitez *et al.*, 2020).

4.4 Analytical structure of Gomes et al. *(2021)*

In the proposal by Gomes *et al.* (2021), the ecosystem is described as a new type of organization called a meta-organization. In this model, a group of interdependent organizations work together without a formal hierarchy but with a shared system-level focus. An ecosystem appears when a single organization or market cannot accomplish value creation through systemic innovation alone. In this situation, diverse, independent, and interconnected actors need to align their activities based on a shared identity to create value. These actors combine their offerings to collectively produce a central systemic innovation, following the partner realignment logic proposed in the "ecosystem-as-structure" approach by Adner (2017).

As per Gomes *et al.* (2021), the meta-organization has a mixed structure, encompassing both necessary and unnecessary attributes, which account for the various forms of ecosystems. In its operating dynamics, a group of interdependent actors establishes and oversees an ecosystem to maintain its competitive edge. These actors engage in activities that complement each other, fostering collaborative value creation for customers and other stakeholders. Aligned with the theoretical model proposed by Granstrand and Holgersson (2020), the attributes proposed by Gomes *et al.* (2021) adopt a more comprehensive approach to ecosystems, emphasizing the co-creation of value and its evolutionary nature.

The changes in the ecosystem dynamics, considering its scope and complexity, require the focal companies to act by designing, planning, and managing the ecosystem. This involves seeking collaboration, coordination, complementarity, and interdependence between partners (Adner, 2017; Jacobides *et al.*, 2018; Gomes *et al.*, 2021). When responding to moves or opportunities by other ecosystem rivals (competitive view), focal companies can modify the ecosystem structure by introducing new roles, new sets of activities, and linkages between actors (configurational view). They may also need to train and manage processes with new actors in the ecosystem, including innovation processes, knowledge management, and uncertainty management. This enables them to carry out new sets of activities (process view) to achieve the desired results of the ecosystem (Gomes *et al.*, 2021).

4.5 Analytical structure of Dedehayir et al. *(2022)*

The analytical structure proposed by Dedehayir *et al.* (2022) focuses on roles rather than individual actors. This is in line with the "ecosystem-as-structure" approach suggested by Adner (2017), which highlights that actors can change roles over time (Dedehayir *et al.*, 2022). The authors emphasize that only a limited set of roles need approval for the ecosystem to emerge and evolve. Their proposition is based on an analysis of the Herceptin drug innovation ecosystem from 1978 (discovery of the drug's basic chemistry) to 1998 (commercialization of the drug).

Based on the role theory, Dedehayir *et al.* (2022) have identified 15 roles that emerge at different stages, challenging the idea that the ecosystem leader is always prominent. The

"specialist" role is particularly active in the initial stages of ecosystem development. On the other hand, the "leader" role becomes more critical during the middle phase of emergence, while the roles of "integrator," "regulator," and "provider" gained prominence in the final stages during operationalization.

This temporal pattern of role prominence serves a tool for predicting the early evolution of an innovation ecosystem. It also improves managerial and policy decision-making regarding the necessary roles for the successful development of the ecosystem.

5. Analytical structures comparison and the theoretical proposition

The analytical structures describe common elements in their definitions and applications. Complementarities and interdependencies, competition and collaboration relationships, and the alignment search are examples of the dynamics between actors. In terms of the ecosystem results, the five analytical structures demonstrate innovative performance from the creation of a higher level of value than those without these interconnections.

The similarities between the analytical structures indicate that the innovation ecosystem literature has found consensus on its concept, with the following steps focused on managing and orchestrating the dynamics of ecosystems. Depending on the ecosystem's value proposition, the activities and the actors' dynamics may change. Thus, an aspect mentioned in the analytical structures is characteristic evolution in the ecosystem, in which roles can change over time, and actors can enter, leave, or even initiate new ecosystems.

When actors play specific roles in developing components and complements, their dynamics impact the proposal and creation of value in the ecosystem. When actors change their position in the ecosystem, they also change their contribution. This change is due to the fact that each group of actors has different motivations and expectations. This situation aligns with the concept that actors have some degree of independence regarding the focal company and each other (Gomes *et al.*, 2021). This is due to potential changes in the value proposition (Benitez *et al.*, 2020) and the evolutionary nature of the situation (Granstrand & Holgersson, 2020; Talmar *et al.*, 2020). It is important to note that the actors' interactions are closely linked to the roles they play in the development of ecosystems (Dedehayir *et al.*, 2022). This finding highlights the interconnectedness of the five analytical structures when understanding ecosystems as a dynamic entity.

Dedehayir *et al.* (2022) emphasize the specific elements of each ecosystem, such as (1) its actors, (2) its activities, and (3) its connections. This specificity makes it challenging to create a comprehensive theory. Therefore, by identifying the roles in an ecosystem, we can analyze the actors' dynamics and observe changes over time while respecting the unique characteristics of each ecosystem. The case of Industry 4.0, as presented by Benitez *et al.* (2020), illustrates this perspective. It highlights that, during its emergent stage, Industry 4.0 progressively defined (1) the actors, (2) the collaboration model, and (3) the value proposition. Furthermore, a business association was established with a regulatory role to develop connections and provide greater trust. Moving from "emergence" to "expansion," the ecosystem redefined its value proposition and assumed a strategic role in delivering complex Industry 4.0 solutions. With this redefined value proposition, the business association changed its function. It is no longer just the actor responsible for connecting companies to resources, but it also contributes to a joint innovation strategy for Industry 4.0.

Thus, although ecosystems are dynamic, only a few studies focus on how they develop over time (Benitez *et al.*, 2020; Gomes *et al.*, 2021; Dedehayir *et al.*, 2022). The discussion of the actor's dynamics is crucial to understand whether any actor plays a leading role in the various evolutionary stages of an innovation ecosystem. Dedehayir *et al.* (2022) refer to this role as the "leader." For instance, in the case of the innovation ecosystem of the *Herceptin*

medication, the focal company was not always the leader, indicating changes in leadership during different stages of development.

When a focal company has an encompassing structure, orchestration falls under the company's purview. This is due to the fact that the company possesses the expertise in the entire process and the technological foundation required to develop the value proposition (Granstrand & Holgersson, 2020; Talmar *et al.*, 2020; Gomes *et al.*, 2021). However, any actor within the ecosystem can engage in orchestration activities (leadership/governance) that contribute to the functioning of the ecosystem (Dedehayir *et al.*, 2022).

If all companies involved in innovation take part in an ecosystem, the research on ecosystem management can improve its understanding of non-focal or non-leading actors (Gomes *et al.*, 2021). Dedehayir *et al.* (2022) support this idea by emphasizing the importance of focusing on other roles beyond the ecosystem leader. According to the authors, studies on different inter-organizational arrangements often overlook various roles at the "periphery," which deserve analytical attention to gain a more comprehensive perspective of the ecosystem structure. This means that other actors can take on the main role without leadership. This supports Talmar *et al.*'s (2020) view that it is essential to understand how companies change their behavior or try to influence the behavior of others based on the analysis of the ecosystem configuration.

Understanding the diverse range of participants in innovation ecosystems is a fundamental step. The success of these ecosystems is not only about achieving mutual support and interdependence in the entire development stage but also in the crucial initial stages. The primary challenge is to effectively manage the delicate interplay of collaboration and competition among participants and to attract and influence them without the need for formal contracts. Equally important is the need to maintain the quality of individual components and complementary elements, as they are the driving force behind systemic innovation (Gomes *et al.*, 2021).

It is essential to consider the inclusion of substitute artifacts and competing actors within an ecosystem's structure, as this can significantly impact its competitiveness compared to other ecosystems (Granstrand & Holgersson, 2020). It is related to Gomes *et al.*'s (2021) observation that actors concentrate on creating and upholding a distinctive value proposition in the context of systemic innovations. It is notable that competition has transitioned from being between individual companies to being between ecosystems.

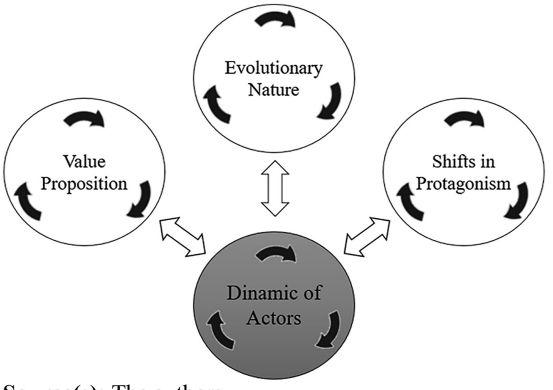
Based on the discussion of the analytical structures, it is proposed that the dynamics of actors depend on the value proposition and the evolutionary nature of the ecosystem. In the initial stages, there is a need for an orchestrator. As the ecosystem evolves and develops, the dynamics of actors can become synchronized and in harmony, allowing for shifts in protagonism. Based on this argumentation, the following theoretical proposition is proposed:

> *Proposition*. The dynamics of actors are shaped by the evolutionary nature and value proposition, as well as changes in protagonism of the innovation ecosystem.

The theoretical proposition suggests that three main factors influence the actors' dynamics in an innovation ecosystem: (1) the evolutionary nature of the ecosystem, (2) changes in the value proposition over time, and (3) shifts in the protagonist orchestrating activities. Figure 1 illustrates our proposition, highlighting the dynamism of innovation ecosystems. This is represented by the arrows interconnecting the elements and directed toward the outcomes of the ecosystem.

The evolutionary nature of an ecosystem refers to the changes that occur throughout its development. These changes do not always lead to the ecosystem's success (Talmar *et al.*, 2020). As the ecosystem evolves, the dynamics of its actors can also undergo modifications, resulting in different interactions and relationships among the participants.

The value proposition of an ecosystem may change over time as the needs and expectations of the participants evolve (Benitez *et al.*, 2020). This may require adjustments in



Source(s): The authors

Figure 1. Representation of the dynamics of actors in an innovation ecosystem

how value is created and delivered. Changes in the value proposition can impact the dynamics of the ecosystem, leading to different actors taking on leadership roles at different stages of development and influencing the direction and focus of the ecosystem. It is crucial to emphasize that managing changes in the scope and value proposition, as well as the modification of the ecosystem's structure are not just important but essential aspects of procedural, configurational, and competitive views from ecosystem management, as highlighted by Gomes *et al.* (2021).

The exchanges of protagonists refer to the actors who take on the role of the leader in an ecosystem, defining a shared vision to ensure that essential complementarities are provided in the value delivered to the customer (Dedehayir *et al.*, 2022). The coordination of activities is crucial in this process, with a particular actor taking the lead in coordinating new activities and aligning the other actors. When significant and radical changes happen, disrupting the system, there is a need for realignment, a shift in the flow of activity, and connections among actors to align with the value proposition. During this realignment, a specific actor must lead the coordination of the new activities involving the other actors.

Our proposal allows for the establishment of parameters to understand the dynamics among actors, ensuring greater applicability in different innovation ecosystem contexts. While Dedehayir *et al.* (2022) focused solely on the emergence stage, we believe it is essential to expand the discussion to the subsequent stages of ecosystem development.

Thus, the originality of our study lies in the understanding that ecosystems must be analyzed as dynamic rather than static entities. While there is already a theoretical understanding of the elements, structure, and functioning of ecosystems there is a need to focus on understanding the changes over time, or the "process." Such advancements, based on the established theoretical proposition, can allow for the definition of a set of functions to identify the dynamics of actors in ecosystems and the best way to manage them (Gomes *et al.*, 2021).

6. Conclusion

In this essay, we focus on the dynamics of actors in analytical structures of innovation ecosystems. Our aim is to understand how these structures address the dynamics of actors and their contribution to the outcome of the ecosystem. Our investigation was guided by five analytical structures that align with the structuralism view of innovation ecosystems. The essay emphasizes the importance of actor dynamics and the need to deepen understanding of this phenomenon in order to manage innovation ecosystems effectively.

The theoretical contribution lies in the knowledge that the dynamics of the actor are shaped by the evolutionary nature of the ecosystem, changes in the value proposition over time, and changes in the protagonist's orchestration. These interconnected factors significantly affect how the players interact, cooperate, and compete in innovation ecosystems. Understanding and managing these aspects are essential for the success and alignment of the ecosystem, ensuring collaborative creation and delivery of value between the actors involved, that is, contributing to the ecosystem result.

The essay aims to enhance our understanding of innovation ecosystems by presenting arguments that explain and theorize the dynamics of the actors involved, their significance, and their impact on the ecosystem's value proposition. The research findings emphasize that ecosystems should not be viewed as static entities with a single value proposition and predetermined actors but rather as dynamic entities in which the value proposition and the roles of the actors can evolve. Therefore, it is crucial to comprehend the dynamics of the actors to achieve better outcomes for the ecosystem.

The findings of this study suggest the potential for creating ecosystem management strategies that are based on the factors influencing the behaviors of key players. These factors include evolutionary characteristics, value proposition, and the exchanges of protagonism. It is important to analyze these factors in an integrated manner when dealing with the behaviors of key players.

The description and discussion of the five analytical structures serve as a guide for managers to understand the dynamics of the ecosystem in sectors with different complexities. Understanding this dynamic enables the comprehension of the evolution and the planning of follow-up actions for this process, allowing the performance of the company and the ecosystem to be enhanced entirely. It is important to note that as they involve complementary relationships, ecosystems may improve the search for complementary actors, comprising a competitive advantage strategy and co-creation of value for all actors. Likewise, managers face the challenge of concurrently cooperating and competing. Thus, they must establish a structure that fosters trust within ecosystems, eliminate the need for contracts, and cultivate a culture of systemic innovation.

The research protocol allowed for a comprehensive analysis of analytical structures based on the structuralism view of innovation ecosystems. This helped identify new research directions on the topic. However, the study was limited by the small number of analytical structures identified in our search. Innovation ecosystems are still new and complex and require replicability in different contexts. It is essential to conduct studies that empirically address the dynamics of actors and further explore the theoretical aspects discussed at various stages of development. Therefore, our proposal highlights the necessity for in-depth studies analyzing specific cases and contexts from a dynamic perspective due to the research gap in understanding the actors' dynamics.

References

Aarikka-Stenroos, L., & Ritala, P. (2017). Network management in the era of ecosystems: Systematic review and management framework. *Industrial Marketing Management*, *67*, 23–36. doi: 10.1016/j.indmarman.2017.08.010.

Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. *Harvard Business Review*, *84*(4), 98–148. Available from: https://hbr.org/2006/04/match-your-innovation-strategy-to-your-innovation-ecosystem

Adner, R. (2017). Ecosystem as structure: An actionable construct for strategy. *Journal of Management*, *43*(1), 39–58. doi: 10.1177/0149206316678451.

Adner, R., & Feiler, D. (2019). Interdependence, perception, and investment choices: An experimental approach to decision making in innovation ecosystems. *Organization Science*, *30*(1), 109–125. doi: 10.1287/orsc.2018.1242.

Adner, R., & Kapoor, R. (2010). Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations. *Strategic Management Journal*, *31*(3), 306–333. doi: 10.1002/smj.821.

Autio, E. (2022). Orchestrating ecosystems: A multi-layered framework. *Innovation*, *24*(1), 96–109. doi: 10.1080/14479338.2021.1919120.

Autio, E., & Thomas, L. D. (2022). Researching ecosystems in innovation contexts. *Innovation and Management Review*, *19*(1), 12–25. doi: 10.1108/INMR-08-2021-0151.

Baldwin, C. Y., Bogers, M. L., Kapoor, R., & West, J. (2024). Focusing the ecosystem lens on innovation studies. *Research Policy*, *53*(3), 104949. doi: 10.1016/j.respol.2023.104949.

Benitez, G. B., Ayala, N. F., & Frank, A. G. (2020). Industry 4.0 innovation ecosystems: An evolutionary perspective on value cocreation. *International Journal of Production Economics*, *228*, 107735. doi: 10.1016/j.ijpe.2020.107735.

Borner, K., Berends, H., Deken, F., & Feldberg, F. (2023). Another pathway to complementarity: How users and intermediaries identify and create new combinations in innovation ecosystems. *Research Policy*, *52*(7), 104788. doi: 10.1016/j.respol.2023.104788.

Carst, A. E., & Hu, Y. (2023). Complementors as ecosystem actors: A systematic review. *Management Review Quarterly*, 1–57. doi: 10.1007/s11301-023-00368-y.

Cobben, D., Ooms, W., Roijakkers, N., & Radziwon, A. (2022). Ecosystem types: A systematic review on boundaries and goals. *Journal of Business Research*, *142*, 138–164. doi: 10.1016/j.jbusres.2021.12.046.

Daymond, J., Knight, E., Rumyantseva, M., & Maguire, S. (2023). Managing ecosystem emergence and evolution: Strategies for ecosystem architects. *Strategic Management Journal*, *44*(4), O1–O27. doi: 10.1002/smj.3449.

Dedehayir, O., Mäkinen, S. J., & Ortt, J. R. (2018). Roles during innovation ecosystem genesis: A literature review. *Technological Forecasting and Social Change*, *136*, 18–29. doi: 10.1016/j.techfore.2016.11.028.

Dedehayir, O., Mäkinen, S. J., & Ortt, J. R. (2022). Innovation ecosystems as structures: Actor roles, timing of their entrance, and interactions. *Technological Forecasting and Social Change*, *183*, 121875. doi: 10.1016/j.techfore.2022.121875.

Fischer, B., Gomes, L., Bernardes, R. C., & Facin, K. (2022). Guest editorial innovation ecosystems: New perspectives and the way forward. *Innovation and Management Review*, *19*(1), 2–11. doi: 10.1108/INMR-02-2022-180.

Ganco, M., Kapoor, R., & Lee, G. K. (2020). From rugged landscapes to rugged ecosystems: Structure of interdependencies and firms' innovative search. *Academy of Management Review*, *45*(3), 646–674. doi: 10.5465/amr.2017.0549.

Gomes, L. A. V., Facin, A. L. F., Salerno, M. S., & Ikenami, R. K. (2018). Unpacking the innovation ecosystem construct: Evolution, gaps, and trends. *Technological Forecasting and Social Change*, *136*, 30–48. doi: 10.1016/j.techfore.2016.11.009.

Gomes, L. A. V., Flechas, X. A., Facin, A. L. F., & Borini, F. M. (2021). Ecosystem management: Past achievements and future promises. *Technological Forecasting and Social Change*, *171*, 120950. doi: 10.1016/j.techfore.2021.120950.

Granstrand, O., & Holgersson, M. (2020). Innovation ecosystems: A conceptual review and a new definition. *Technovation*, *90*, 102098. doi: 10.1016/j.technovation.2019.102098.

Hakala, H., O'Shea, G., Farny, S., & Luoto, S. (2020). Re-storying the business, innovation and entrepreneurial ecosystem concepts: The model-narrative review method. *International Journal of Management Reviews*, *22*(1), 10–32. doi: 10.1111/ijmr.12212.

Hannah, D. P., & Eisenhardt, K. M. (2018). How firms navigate cooperation and competition in nascent ecosystems. *Strategic Management Journal*, *39*(12), 3163–3192. doi: 10.1002/smj.2750.

Hieu, V. M., (2021). Firm's innovation ecosystem: Barriers, key success factors and strategies. *Webology*, *18*(SI03), 14–24. doi: 10.14704/WEB/V18SI03/WEB18017.

Hou, H., & Shi, Y. (2021). Ecosystem-as-structure and ecosystem-as-coevolution: A constructive examination. *Technovation*, *100*, 102193. doi: 10.1016/j.technovation.2020.102193.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. *Strategic Management Journal*, *39*(8), 2255–2276. doi: 10.1002/smj.2904.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2024). Externalities and complementarities in platforms and ecosystems: From structural solutions to endogenous failures. *Research Policy*, *53*(1), 104906. doi: 10.1016/j.respol.2023.104906.

Kapoor, R. (2018). Ecosystems: Broadening the locus of value creation. *Journal of Organization Design*, *7*(1), 1–16. doi: 10.1186/s41469-018-0035-4.

Klimas, P., & Czakon, W. (2022). Species in the wild: A typology of innovation ecosystems. *Review of Managerial Science*, *16*(1), 249–282. doi: 10.1007/s11846-020-00439-4.

Paasi, J., Wiman, H., Apilo, T., & Valkokari, K. (2023). Modeling the dynamics of innovation ecosystems. *International Journal of Innovation Studies*, *7*(2), 142–158. doi: 10.1016/j.ijis.2022.12.002.

Phillips, M. A., & Ritala, P. (2019). A complex adaptive systems agenda for ecosystem research methodology. *Technological Forecasting and Social Change*, *148*, 119739. doi: 10.1016/j.techfore.2019.119739.

Pushpananthan, G., & Elmquist, M. (2022). Joining forces to create value: The emergence of an innovation ecosystem. *Technovation*, *115*, 102453. doi: 10.1016/j.technovation.2021.102453.

Ritala, P., & Almpanopoulou, A. (2017). In defense of 'eco' in innovation ecosystem. *Technovation*, *60*, 39–42. doi: 10.1016/j.technovation.2017.01.004.

Suominen, A., Seppanen, M., & Dedehayir, O. (2019). A bibliometric review on innovation systems and ecosystems: A research agenda. *European Journal of Innovation Management*, *22*(2), 335–360. doi: 10.1108/EJIM-12-2017-0188.

Talmar, M., Walrave, B., Podoynitsyna, K. S., Holmström, J., & Romme, A. G. L. (2020). Mapping, analyzing and designing innovation ecosystems: The Ecosystem Pie Model. *Long Range Planning*, *53*(4), 101850. doi: 10.1016/j.lrp.2018.09.002.

Teece, D. J. (2018). Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world. *Research Policy*, *47*(8), 1367–1387. doi: 10.1016/j.respol.2017.01.015.

Thomas, L. D. W., & Autio, E. (2020). Innovation ecosystems in management: An organizing typology. In *Oxford Encyclopedia of Business and Management*. Oxford University Press. doi: 10.1093/acrefore/9780190224851.013.203.

Thomas, L. D., & Ritala, P. (2022). Ecosystem legitimacy emergence: A collective action view. *Journal of Management*, *48*(3), 515–541. doi: 10.1177/0149206320986617.

Thomas, L. D., Autio, E., & Gann, D. M. (2022). Processes of ecosystem emergence. *Technovation*, *115*, 102441. doi: 10.1016/j.technovation.2021.102441.

Walrave, B., Talmar, M., Podoynitsyna, K. S., Romme, A. G. L., & Verbong, G. P. (2018). A multi-level perspective on innovation ecosystems for path-breaking innovation. *Technological Forecasting and Social Change*, *136*, 103–113. doi: 10.1016/j.techfore.2017.04.011.

Supplementary file 1

Analytical structures	Objective	Main results
Granstrand and Holgersson (2020)	Analyze the various definitions of innovation ecosystems and related concepts and propose a synthesized definition of an innovation ecosystem	Twenty-one unique definitions of innovation ecosystems were identified. A generalist concept was proposed based on the main elements identified: actors, activities, artifacts, institutions, and their substitution and complementarity relationships. Such features contemplate the proposed model in an image
Talmar *et al.* (2020)	Propose a strategy tool to model (map, analyze, and design) ecosystems according to the structuralism approach (Adner, 2017)	The *Ecosystem Pie Model* (EPM) was developed with extensive application guidelines. The tool considers and integrates relevant ecosystem properties, such as interdependence, alignment risks, and complementarities
Benitez *et al.* (2020)	Understand how ecosystems can consolidate and evolve and how value is co-created	It provides an understanding of technology delivery in digital transformation for Industry 4.0. It follows the ecosystem approach, which considers it more appropriate than a supply chain perspective for complex interrelationships
Gomes *et al.* (2021)	Propose an understanding of the ecosystem as a meta-organization to manage collaboration, coordination, complementarity, and interdependence	The ecosystem was presented as a composite structure of necessary and not necessary attributes for its characterization. The model advances the discussion on ecosystem management by emphasizing the notion of the ecosystem as a meta-organization and describing management based on a processual, configurational, and competitive perspective
Dedehayir *et al.* (2022)	Propose a framework that defines a cast of roles and determines the timing of their entry onto the stage of ecosystem emergence, and in turn, describes the interaction of to these roles that govern emergence	It revealed a set of 15 roles that facilitate the emergence of innovation ecosystems, performed at the individual, team/group, and organizational levels. Different parts have gained prominence in other analyses carried out in recent years, and the actors who assume them bring broader conceptual applicability Since actors, their activities, and interconnections are specific to each ecosystem

Source(s): The authors based on Granstrand and Holgersson (2020), Talmar *et al.* (2020), Benitez *et al.* (2020), Gomes *et al.* (2021), and Dedehayir *et al.* (2022)

Table A1.
Analytical structures of innovation ecosystems

Supplementary file 2

Analytical structure	Actors dynamics	Result
Granstrand and Holgersson (2020)	- Complementary/substitute relationships with each other - A system of actors that relate collaboratively and competitively, with or without the focal company, connected through input and output flows together to deliver a value proposition - A sharing of technologies, essential in the creation and capture of value within and between sets of actors - Cases emphasize complementary (collaboration) and substitute (competition) relationships	Innovative performance for the actors
Talmar *et al.* (2020)	- Constructions and relationships relevant to the representation of the functioning of an innovation ecosystem - Relevant properties (interdependence, complementarities, and alignment risks) - Constructs and their relationships were defined at the ecosystem level (value proposition, user segments, and actors) and at the actor level (resources, activities, value addition, value capture, dependency, and risk)	- Alignment of actors based on the value proposition - Creating more excellent value, exploring the synergies and effects of complementarities between actors
Benitez *et al.* (2020)	- Actors who need to interact to co-create value and relate in different ways according to the evolutionary stage of the innovation ecosystem - Self-organized or managed with multilayer networks of actors with other attributes, seeking to provide a system of innovative products and services - Companies with diffuse technological capabilities or aligned around industry platforms - Theory of Social Exchanges: trust, reciprocity, the expectation of mutual benefits from voluntary value exchanges, obligations between the parties involvedetc.	- Structure-guided by platforms or technologies that drive relationships for the co-creation of value - A variety of actors creates symbiosis and synergies to create a higher level of value than those without these interconnections
Gomes *et al.* (2021)	- The ecosystem as a meta-organization, composed of a group of actors that pursue a collective goal at the system level, the focal value proposition - Heterogeneous set of independent actors, but at the same time interdependent, who are "limited" by complementarities - Different collaboration and competition dynamics between ecosystem members and the external environment - The meta-organization (ecosystem) emerges when the actors' activities must be aligned based on a collective identity to create value (systemic innovation)	The performance of the ecosystem (value proposition – systemic innovation) presents it as a meta-organization that must be managed based on three visions: *process, configuration, and competitive vision*

Table A2.
Actors dynamics in the analytical structures

(*continued*)

Analytical structure	Actors dynamics	Result
Dedehayir *et al.* (2022)	- They understand innovation ecosystems as the process of incorporation and connection of actors within an evolving ecosystem structure, with an emphasis on the emergence process - They propose a focus on the roles played, whereby the dynamics of the actors will be linked to the different parts they can assume throughout the evolution of the ecosystem	- Emergence of an innovation ecosystem that develops a proposal, generating complementarities and value creation

Source(s): The authors based on Granstrand and Holgersson (2020), Talmar *et al.* (2020) and Benitez *et al.* (2020), Gomes *et al.* (2021), and Dedehayir *et al.* (2022)

Table A2.

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