

From governance to choreography: coordination of innovation ecosystems

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Abstract

Purpose – Innovation ecosystems can emerge and grow organically, but the process can also be managed through conscious intervention. Therefore, this study observes different motivations and expectations for each group of actors. The lack of alignment between actors could have a negative influence on the development of innovation ecosystems. This study aims to analyze the coordination strategies of the actors throughout the life cycle of innovation ecosystems.

Design/methodology/approach – This study develops and proposes a model for coordinating innovation ecosystems based on the theoretical backgrounds of the ecosystem life cycle and ecosystem coordination.

Findings – This study argues that each stage of an innovation ecosystem's life cycle – inception, launching, growth and maturity – demands different coordination strategies. Initially, networks are simpler and thus the coordination issues are less difficult. However, as the ecosystem evolves and the complexity of the networks increases, a more sophisticated strategy, such as orchestration or choreography, is needed.

Research limitations/implications – This is a theoretical study that recommends further research to test this model.

Practical implications – The understanding of coordination and stages of the life cycle of an innovation ecosystem can guide actors in the design of strategies for developing of ecosystems.

Social implications – The proposed framework could support strategies to engage civil society in actions to develop innovation ecosystems.

Originality/value – This study presents a framework to understand the coordination strategies better, considering the stages of an innovation ecosystem's life cycle.

Keywords Innovation ecosystem, Ecosystem coordination, Ecosystem life cycle

Paper type Research paper

1. Introduction

Fostering innovation ecosystems is an increasingly adopted strategy by governments around the world to promote socioeconomic development, from Massachusetts (Reynolds, & Uygun, 2018) and the Silicon Valley (Piqué, Berbegal-Mirabent, & Etzkowitz, 2018a), in the USA, to Barcelona, Spain (Piqué, Miralles, & Berbegal-Mirabent, 2019) and Porto Alegre, Brazil (Zen, Santos, Faccin, & Gonçalves, 2019). Many policymakers have noticed that a city or a region often invests many resources in qualifying human capital. Still, suppose it does not provide opportunities nor the necessary conditions for these talents to work and have a good quality of life. In that case, they usually migrate to other localities and thus stop contributing



to the development of the place where they were born or trained (Dirks, Gurdgiev, & Keeling, 2010; Betz, Partridge & Fallah, 2016; European Union, 2016). To retain these talents and promote development, innovation ecosystems have been seen as a holistic solution to have a vibrant city, which generates opportunities continuously and is invigorated at all times to offer a high quality of life to its citizens.

At the city level, an innovation ecosystem can be defined as a set of interdependent actors with conflicting technical, social, economic and political interests, but also converging goals, priorities, expectations and behaviors that cooperate and compete concomitantly in a specific geographical location. Thus, innovation ecosystems are hybrids of different networks and systems with fractal, multilevel, multimodal, multinodular and multilateral configurations, with tangible and intangible dynamic assets designed to promote innovation in a territory (Carayannis, Grigoroudis, Campbell, Meissner, & Stamati, 2018).

The innovation ecosystems can emerge and grow organically; however, the process can also be managed through conscious intervention. In this way, Heaton, Siegel and Teece (2019) argue that the resources must be orchestrated by a strong player willing to take the lead, especially in the city context, where each group of actors usually have different motivations and expectations. The lack of alignment between actors could negatively influence the development of innovation ecosystems (Bittencourt, Zen, Schmidt, & Wegner, 2018).

Conversely, due to their evolutionary nature, innovation ecosystems develop and change over time, according to life cycle stages. However, despite the importance of understanding how the dynamics of innovation ecosystems work, the concept of life cycle is undertheorized in this field (Rabelo & Bernus, 2015; Piqué *et al.*, 2019; Cantner, Cunningham, Lehmann, & Menter, 2020). Each stage of a life cycle presents distinct characteristics and behaviors from actors. Thus, these idiosyncratic configurations demand different coordination strategies to mobilize the actors, align the interests and create a common agenda.

This study analyzes the coordination strategies used for the actors' alignment throughout the life cycle of innovation ecosystems. We argue that each stage of the life cycle of innovation ecosystem demands different coordination strategies. As an interdependent network of actors, this coordination can be more formal, in which we can easily identify the leader and agenda. However, when the network has stability and complexity, ecosystem coordination can be more informal or even diffuse among actors.

We identified a gap in the literature about this dynamic of the ecosystem's life cycle and coordination strategies in each stage. The literature in innovation ecosystems presents a substantial growth in the last decade (Suominen, Seppänen, & Dedehayir, 2019), yet few authors explore the life cycle of the innovation ecosystem (Piqué *et al.*, 2019) and even the dynamic roles for actors to lead the ecosystem (Heaton, Siegel, & Teece, 2019; Bittencourt, Zen, & Santos, 2020). Moreover, each life cycle stage has its idiosyncrasies and thus calls for a distinct coordination strategy.

As a theoretical contribution, we propose a reflection about actors' coordination strategies in an innovation ecosystem. Based on the life cycle models in inter-organizational arrangements, we argue that the inception stage demands a more centralized and formal strategy to align actors' motivation and activities. Otherwise, in the maturity stage, when the actors build trust, this coordination could be more decentralized and informal. Hence, we also present a framework to understand the coordination strategies better, considering the stages of an innovation ecosystem's life cycle.

This study is structured as follows. In Section 2, we present the theoretical background on the geographically bounded innovation ecosystem and its life cycle. In Section 3, we explain the actors' coordination strategies. In Section 4, we propose a framework of actors' coordination in the life cycle of innovation ecosystems. Finally, in Section 5, we draw contributions, implications and suggest further research.

2. Geographically bounded innovation ecosystem and its life cycle

In geographically bounded innovation ecosystems, i.e. a city or a region, agglomeration can provide benefits such as knowledge spillovers and ease access to resources (Cantner *et al.*, 2020). Colocation effects leverage the transfer of tacit knowledge (Presutti, Boari, & Majocchi, 2013). The physical proximity between actors also helps them engage in partnerships to access complementary resources in the environment or with other actors, share resources and build relational resources (Dyer, Singh, & Hesterly, 2018).

Therefore, at the same time actors compete for scarce resources, they must also cooperate to achieve a competitive advantage. We consider that the actors in an innovation ecosystem can be grouped according to the quadruple helix model (Carayannis & Campbell, 2009). The quadruple helix model emphasizes the importance of interaction between academia, companies, government and civil society so that processes of creation, diffusion and application of new knowledge occur, which can result in new technologies and, ultimately, through the capture and delivery of economic and social value, territorial development (Cavallini, Soldi, Friedl, & Volpe, 2016; Carayannis *et al.*, 2018).

The academia group is composed by institutions that contribute to the ecosystem, mainly through the qualification of human capital, production and dissemination of knowledge, such as universities and other institutions of higher education and research. The company group includes startups, large companies, science and technology parks, business incubators and accelerators, angel and risk investors and commercial banks. The actors engaged in transforming knowledge into new products and solutions. In turn, the government group of actors is responsible for the institutional conditions that influence and guide the ecosystem; these actors are the government agencies, regulatory agencies and public development banks. Finally, civil society encompasses all individuals and organizations that benefit from innovation and help achieve it, such as professionals from the creative class, the first users, professionals supporting innovation and entrepreneurship, famous icons, opinion makers, experienced entrepreneurs, family and friends.

The inclusion of civil society allows a “bottom-up” approach. Thus, the quadruple helix model maintains the interaction between the actors of the triple helix – academia, companies and government – and formalizes society’s participation in the innovation process to foster locoregional socioeconomic development. Such a perspective allows territories to follow nontraditional innovation paths, including creating services, exploring creativity, non-technological improvements and open innovation (Cavallini *et al.*, 2016).

The inclusion of civil society among the actors is especially relevant in innovation ecosystems since citizens’ needs are better understood and evaluated in this way. In a context of increasing complexity, in which characteristics such as transdisciplinarity and hybridization of knowledge become essential for the innovation process, the public interest must be considered to discover and generate innovations that will promote social welfare (Yawson, 2009). With the fourth helix, innovation expands its technological focus and becomes a tool for overcoming urban challenges through sustainable transformations (Borkowska & Osborne, 2018).

In this study, individual users are considered members of civil society, such as customers, citizens or community members, who interact with academia, the government and companies. These members use, benefit and help achieve innovations that may contribute to their well-being and the socioeconomic development of the territory. Therefore, civil society requires active participation in the innovation process, contributing with its knowledge, inventiveness and creativity, and providing constant feedback so that the solutions generated are appropriate to its needs (Cavallini *et al.*, 2016). The quadruple helix model assumes that society demands innovation in goods and services and becomes an active part of the innovation process (Etzkowitz, & Leydesdorff, 2000). An innovation ecosystem’s effective coordination is needed to assure the participation and balance among the quadruple

helix actors. Digitalization and information and communication technologies can help in this process (Cavallini et al., 2016). The quadruple helix has an explicit focus on the dynamically interwoven cooperation processes, coevolution of different types of knowledge and co-expertise, in the context of territorial innovation ecosystems (Carayannis et al., 2018). For this coordination to work appropriately, there is a need to understand in which stage of its life cycle the ecosystem is.

2.1 Life cycle of innovation ecosystems

The concept of life cycle of innovation ecosystems can be understood to be analogous to the biological systems in which the species born, develop and die. However, the stream of research in innovation ecosystems has modestly explored the theme of life cycle (Rabelo & Bernus, 2015; Piqué et al., 2019). Therefore, to search for models dealing with the stages of the ecosystem life cycle, we considered the connection of this theme with the field of studies on geographic agglomerations (Spigel, & Harrison, 2018), such as clusters (Menzel & Fornahl, 2010), entrepreneurial ecosystems (Cantner et al., 2020) and business ecosystems (Moore, 1993).

Within the cluster approach, the study of Menzel and Fornahl (2010) is one of the references in the cluster life cycle topic. These authors argue that clusters emerge, grow, sustain and decline. According to this model, what drives the cluster's evolution is the diversity and heterogeneity of knowledge within it. Therefore, if the cluster can incorporate and exploit new knowledge, it evolves to a new stage of growth; however, if it fails, the cluster loses its competitive advantage and becomes imprisoned, thus achieving a stage of technological exhaustion.

In the ecosystem literature, Moore (1993) pointed out that ecosystems have development stages. These stages would be: birth, expansion, leadership and self-renewal or death. In the birth phase, there is a shared understanding among the actors on what are the common objectives, thus assuring the collaboration among them and the delivery of value. In the expansion stage, the relationships between the actors are strengthened and the ecosystem grows. The growing ecosystem starts to be competitive and to compete against other ecosystems. In the leadership phase, the ecosystem is a leader in one or more features, being more stable and richer in networks and generating value. As the competitiveness and complexity grow, the issues related to the coordination of the ecosystem improve simultaneously. The final stage is self-renewal or death. The ecosystem must explore new knowledge to invigorate or be terminated due to not being competitive anymore.

Cantner et al. (2020), in their dynamic life cycle model for entrepreneurial ecosystems, propose that the life cycle of ecosystems can explain how they arise and evolve. The authors propose a model consisting of five sequential phases: birth, growth, maturity, decline and reemergence. The event that characterizes the birth phase is an idea, referring to the recombination that leads to innovation, i.e. a new arrangement of existing resources to generate value for the quadruple helix actors. In the growth phase, actors become more specialized and start to use and combine resources to develop the ecosystem. Also, in this phase, the culture will be more favorable to entrepreneurship and innovation. The maturity stage is achieved when there is a stabilization of entrepreneurial and innovative activities and fewer incentives to entrepreneurship and innovation because the opportunity costs are higher. There is fewer entrepreneurial activity in the decline phase, and the ecosystem gets imprisoned in a specific technological regime; therefore, radical innovations are less likely to happen. This also makes the ideal scenario for new opportunities and for the reemergence of the ecosystem. Finally, in the reemergence phase, the entrepreneurial activity is resumed and there is space for the exploitation of new technological opportunities (Cantner et al., 2020).

There are also models describing the life cycle of a regional innovation ecosystem (Rabelo, & Bernus, 2015) or an innovation ecosystem of a specific district (Piqué *et al.*, 2019). Rabelo and Bernus (2015) argue that the phases of the life cycle of an innovation ecosystem are “Analysis,” in which the decision to create the ecosystem is made; “Project” when the architecture of the ecosystem is defined; “Deployment,” through the recruitment of key actors, the dissemination and establishment of formal and infrastructure conditions for the ecosystem to operate; “Execution,” with ecosystem management activities; “Conclusion,” in which the ecosystem goes through a metamorphosis to survive and continue to develop or is decommissioned; and last, “Sustenance,” which is responsible for the future evolution and viability of the ecosystem.

According to Piqué *et al.* (2019), a specific district’s innovation ecosystem evolves through four stages: inception, launching, growth and maturity. The inception phase starts when there is a need to create an urban innovation ecosystem where talent, knowledge and capital can exist and be exploited. After a strategy for creating the innovation ecosystem, it must have the necessary infrastructure to work, and actors must be attracted and articulated to understand their roles. The next stage is growth. The ecosystem already has an initial structure and starts to be more competitive, thus stimulating new businesses and causing governance challenges. Finally, in the maturity stage, the ecosystem expands its internationalization and its leadership position; hence, its networks and resources call for orchestration to be internationally competitive and exploit new opportunities.

We add to these models the idea that the ecosystem does not necessarily go to the following phases for each phase. Given the complexities, dynamics and natural conflicts existing inside it between the actors, the ecosystem can recede to one of the preceding phases without having completed the entire roadmap of the life cycle model. Thus, we propose that for a true dynamic life cycle model, both the possibilities of going forward (evolution) or going backward (involution) must be considered.

Therefore, we consider that the ecosystem evolves through the stages proposed by Piqué *et al.* (2019): inception, launching, growth and maturity. In the inception stage, actors and resources are spread and demobilized. Then, a strategy is needed for the emergence of the ecosystem. After in the launching phase, the strategy starts to be executed and both actors and resources start to be mobilized. In the stage of growth, there is an acceleration of collaboration processes and joint involvement in the development of the ecosystem. When the innovation ecosystem becomes vibrant, and interactions begin to flow more organically, it reaches the maturity stage.

Depending on the maturity of the ecosystem, there is a chance of existing a group of actors that get access to resources but do not contribute with their own resources. Thus, ecosystems must have an effective coordination strategy to mitigate this behavior and maintain a trusting environment where the other actors are still willing to collaborate and engage in joint actions. We propose that to assure collaboration among actors, innovation ecosystems can have formal or informal coordination mechanisms (Dyer & Hatch, 2006; Autio & Thomas, 2014), according to their stage of maturity or life cycle phase. A formal mechanism considers the existence of contracts, rules and regulations. An informal mechanism depends on the norms of reciprocity and trust among actors, given that they sustain the relationships among actors (Provan, Fish, & Sydow, 2007). Next, we discuss the different types of ecosystem coordination.

3. Coordination of innovation ecosystems

Managing innovation ecosystems or networks is not a new issue, but the discussion on the phenomenon has been on the rise in recent years (Möller & Halinen, 2017; McDermott, Mudambi, & Parente, 2013). Because of those relations’ complexity, it becomes necessary to

understand which is the best model of management (Lumineau, & Oliveira, 2018; Majchrzak, Jarvenpaa & Bagherzadeh, 2015). The process of innovation is a multifaceted and complex task (Pikkarainen, Ervasti, Hurmelinna-Laukkanen, & Nätti, 2017), even more in environments where there is a significant number and diversity of actors (Reypens, Lievens, & Blazevic, 2021), as the case of innovation ecosystems. Thus, innovation ecosystems' success calls for careful direction and coordination (Hurmelinna-Laukkanen, & Nätti, 2018).

According to the literature, it is possible to identify different approaches that seek to understand how these ecosystems can be managed. Most discussions of management/coordination of networks of inter-organizational relationships are related to the concept of network governance (Provan & Milward, 2001; Provan, Isett, & Milward, 2004). However, when it comes to innovation networks or ecosystems, the most used approaches have been orchestration (Hurmelinna-Laukkanen & Nätti, 2018; Pikkarainen *et al.*, 2017; Dhanaraj & Parkhe, 2006) and choreography (Ferraro & Iovanella, 2015). We notice that each of these lenses brings different perspectives in relation to the maturity of the ecosystem or network, the complexity of relationships and management's centralization.

Provan and Kenis (2008) identified three basic network governance modes from which hybrid models can be generated. The simplest mode is shared governance, where a group of organizations collectively works as a network despite not possessing a structure of exclusive and formal management. The second mode is the lead organization-governance, which typically occurs in relationships formed by a bigger, more powerful organization and a set of lesser, weaker firms (Provan & Kenis, 2008). The third mode is the network administrative organization (NAO), where an administrative entity is created, especially to manage the network and its activities.

According to Provan and Kenis' (2008) proposal, four contextual variables act as key predictors of the effectiveness of network governance modes: the level of trust among network members, the number of participants, the level of goal consensus and the need for network-level competencies. The relationship between these predictors should enable identifying the mode of governance best suited to the network, as no mode of governance is necessarily superior in every situation. However, choosing the best mode of governance is not a guarantee of success. As stated by Provan and Kenis (2008, p. 14), "network managers operating within each form must recognize and respond to three basic tensions, or contradictory logics, that are inherent in network governance." These tensions refer to the efficiency of the network versus the inclusiveness of its members in decisions and deliberative activities, the internal versus external legitimacy of the network, and the flexibility versus stability of the network. The management of these tensions is critical to the efficacy of the network: Despite the absence of empirical research on how these three tensions occur regarding network governance, they are essential, but problematic, aspect of network management (Provan & Kenis, 2008, p. 18).

However, we realize that the term governance, widely used in networks, clusters and business arrangements, focuses on institutional organization, a meso perspective. Thus, in broader networks – such as innovation ecosystems – approaches such as orchestration and choreography have been used, seeking to contemplate this type of network's fluidity. Dhanaraj and Parkhe (2006) originally defined the orchestration model as the set of deliberate, purposeful actions undertaken by a central actor to create and extract value from a network. The orchestration of innovation networks is a theoretical approach that focuses on the organization and leadership in multi actors' relations (Young, 1982; Mintzberg, 1998; Dhanaraj & Parkhe, 2006). Such capacity may cover different processes according to its applicability, comprehending a set of actions conducted by one orchestrator (Dhanaraj & Parkhe, 2006; Nambisan & Sawhney, 2011; Hurmelinna-Laukkanen, Möller, & Nätti, 2011).

Network orchestration denotes the act of performing a leadership role, without the benefit of hierarchical authority. Orchestration emerges as a set of activities aimed at developing,

managing and coordinating a set of actors that seek to create and extract value from the network (Dhanaraj & Parkhe, 2006). Fung, Fung and Wind (2007) support that definition bringing the orchestration as a capacity to unite several different expertise so that there is a harmony capable of creating value. "It is about activities that allow and ease (but do not dictate) the coordination of the network for the performance of the results of innovation" (Ritala, Hurmelinna-Laukkanen, & Nätti, 2012, p. 325).

In the seminal study, Dhanaraj and Parkhe (2006) developed three processes based on other more specific variations and for the descriptions of the orchestration of the innovation networks: the mobility of knowledge, appropriability of innovation and network stability. Nevertheless, the processes and the model proposed by Dhanaraj and Parkhe (2006) are being increasingly questioned due to the emergence of more complex and heterarchical networks.

Usually, the orchestration of an innovation network was performed by a hub company (Dhanaraj & Parkhe, 2006). However, in some situations, the roles and activities of network coordination for the performance of innovation results can go beyond the model based on the set of actions of a hub company when considering all the network (Hurmelinna-Laukkanen, & Nätti, 2018). Studies have been pointing out that multiple orchestrators with distinct roles can generate more innovations for the organizations and networks (Hurmelinna-Laukkanen & Nätti, 2018), besides having identified that the orchestration influences differently the individual and organizational levels (Ritala, Armila & Blomqvist, 2009). Therefore, the orchestration varies according to the stage of network development (Nilsen & Gausdal, 2017). To summarize, we can identify two theoretical lines in the orchestration approach: the first advocated by Dhanaraj and Parkhe (2006) with a centralized management in a hub company and the second line that presents a decentralized model with multi-orchestrators (Hurmelinna-Laukkanen & Nätti, 2018; Pikkarainen *et al.*, 2017).

More complex and heterarchical organizations have emerged with more than one hub, in which the power of decisions is spread among all partners. When this occurs, the orchestration model is no longer suitable to describe such an environment (Ferraro & Iovanella, 2015). In this context, Ferraro and Iovanella (2015) introduce the choreography model, which considers all members of the network without relying on one core actor. The choreography governs behaviors by shaping the level of connectivity and cohesion among network members. It represents a valid organizational system that can sustain certain activities and achieve effects that generate innovation outcomes.

The word "choreography" is derived from the Greek words for "dance" χορεία and "write" γραφία, reflecting the sequence of steps and movements in dance, and the art or the practice of designing choreographic sequences. The emergence of choreography in a network leads to the establishment of coordinated activities among all members, which allow the creation and extraction of innovation through the outcomes (Ritter *et al.*, 2004). This last piece of evidence suggests that developing a new framework, called "choreography," defined as the network's capacity to address collaboration among multiple members. The presence of choreography results in the establishment of coordinated activities among all members and produces heightened innovation (Ferraro & Iovanella, 2015).

Choreography is focused on inter-organization coordination for external perspectives (Nambisan & Sawhney, 2011), while self-organizing interactions address collaboration. Ferraro and Iovanella (2015) argue that the emergence of choreography involves the performance of specific activities among the members of the innovation network, which are the management of the flow of knowledge, management of the appropriability of innovation, management of the stability of the and management of the vitality and health of the network. Such activities are similar to the key processes required for a hub in orchestration, but with the difference that the choreography is self-organized (Ferraro & Iovanella, 2015).

To summarize, we identified that the relationship between orchestration and choreography is related to the networks' complexity and the centralization of its coordination. Thus, the

orchestration appears to seek to explain simpler networks coordinated by a hub company. As the literature presented more complex networks, it was noticed that the number of orchestrators was increasing. Finally, the choreography approach that offers a decentralized model for increasingly complex networks. In the next section, we seek to explain how the ecosystem's coordination can change according to its life cycle and, therefore, its complexity.

4. Actors' coordination in the life cycle of innovation ecosystems

According to the life cycle and coordination approaches for innovation ecosystems, we identified different strategies of coordination that are more effective to engage and mobilize actors for joint actions in the development of an innovation ecosystem. In the initial stages of an innovation ecosystem's life cycle, networks are simpler and thus coordination issues are less difficult. However, as the ecosystem evolves and the complexity of the networks increases, a more sophisticated strategy, such as orchestration or choreography, is needed, as shown in Figure 1.

In the inception stage, actors are dispersed, and resources are not mobilized. Thus, a strategy is needed to mobilize the actors, align actions and define common objectives and agendas. In this stage, it is also when trust starts to be built. Hence, to ensure cooperation while still being low levels of trust among the actors, the most effective control mechanism will be a more centralized, such as governance. This finding raises our first proposition (*P1*):

- P1.* During the inception stage of an innovation ecosystem, coordination is centralized through a governance structure to mobilize actors, align actions and propose a common strategy.

The same happens in the next stage when the ecosystem has the basic infrastructure for innovation and the actor starts to be articulated and resources mobilized. However, the ecosystem dynamics are not well organized yet, and trust among actors is still scarce; thus, the potential of resources cannot be fully exploited. In this stage, there is still a need for trust-building and a formal mechanism of control. Therefore, in both the inception and in the launching stages, the ecosystem calls for more centralized coordination. However, in the latter there is a simple network to be coordinated, which can be done through an orchestration strategy and a hub organization. Our second proposition arises from this finding:

- P2.* During the launching stage of an innovation ecosystem, a simple network is formed, so orchestration becomes necessary.

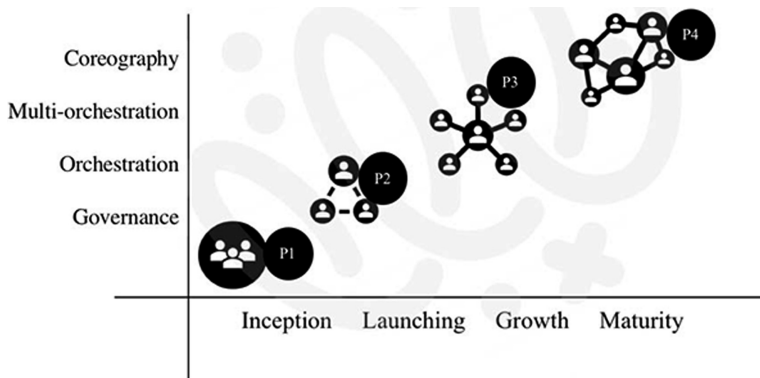


Figure 1.
Framework of Actors'
Coordination in the Life
Cycle of Innovation
Ecosystems

In the subsequent stages, actors trust each other and collaborate better. In the growth stage, it is possible to observe that actors can manage their own interdependencies for the ecosystem to benefit from their actions. However, the coordination in this phase becomes more complex and the networks themselves. Hence, the coordination mechanism to be adopted must maintain a certain degree of responsibility and control, but which does not plaster the behavior of actors or the evolution of the ecosystem. This way, decentralization allows that multiple leaders (multi-orchestrators) take control over the ecosystem coordination. Accordingly, we present our third proposition:

- P3.* During the growth stage of an innovation ecosystem, the network of actors becomes more complex and the number of member increases, making multi-orchestration necessary.

Finally, in the maturity stage, it is possible to suppose that are high levels of trust among actors and that the ecosystem can compete internationally against other ecosystems. The mature ecosystem is a rich environment supportive of innovation where innovation happens systematically and organically. In this stage, a highly decentralized mechanism of coordination is possible and effective. The actors understand their roles and can communicate and articulate with other actors without any intermediary. In the maturity phase, the alignment of actors is built and they can complement each other to strengthen the ecosystem. This last coordination mechanism, in which it is possible to have shared leadership in the process of self-organization, is called “choreography.” Thus, we have our fourth proposition:

- P4.* During the maturity stage of an innovation ecosystem, there are high levels of trust and alignment between the actors, making it possible to adopt choreography as the coordination mechanism.

5. Conclusion

Innovation ecosystems are of utmost importance for territorial development. For that to happen, the quadruple helix actors must be engaged in joint actions that effectively contribute to a better ecosystem. However, there is a challenge regarding how to coordinate these actors, given that they may have not common objectives but also conflicting interests. According to their life cycle stage, innovation ecosystems can have distinct coordination mechanisms. For each stage, we identified a better coordination strategy.

Therefore, in this study, we propose a need for more control in the first stages of the innovation ecosystem to align the actors and their interests. Thus, in the inception stage, innovation ecosystems call for a formal coordination system. Given its dynamics are not well organized, trust among actors must be built from scratch, and actors and resources must be mobilized. In the launching stage, there is an evolution since the necessary infrastructure is ready. However, actors still need to be articulated, and trust still needs to be built; thus, centralized coordination is better. However, in the subsequent stages, the networks become more complex and require a coordination mechanism that allows decentralization. Then, in the growth stage, the orchestration of actors and resources enables an adequate degree of decentralization, reaching multiple orchestrators' development. Finally, in the last stage, maturity, it is possible to have choreography as an organic coordination mechanism, in which leadership is shared in a self-organization process.

An effective coordination mechanism for each phase of an innovation ecosystem's life cycle can be of great value for all actors and the ecosystem itself. The benefits of the ecosystem include better quality of life and a more developed city. For the actors, there are also many benefits in joining a collective movement for innovation, such as access to complementary resources, knowledge spillovers and more competitiveness.

Knowing which coordination mechanism is the most suitable for each life cycle stage of an innovation ecosystem can help both practitioners and researchers achieve their respective objectives. For public managers, ecosystem builders and other leaders and executives in general, our framework can provide a map for understanding the dynamics and evolution of the ecosystems they are in, giving insights for more accurate interventions. This study also advances the literature on innovation ecosystems, especially regarding understanding the life cycle stages and the most appropriate coordination mechanism for each stage. Thus, this study's four propositions can strengthen the knowledge of these topics, which still need further exploitation within the field of innovation ecosystems.

This theoretical study is a first attempt at explaining how it works in the coordination of innovation ecosystems. Our framework opens an avenue for future studies that can help validate our model. First, it would be valuable to verify in practice the validity of the four propositions we listed in this study and its central argument that there is a coordination mechanism that suits the most for each stage of the life cycle of an innovation ecosystem. Both quantitative and qualitative studies can be conducted to validate our theoretical propositions. For example, to perform an empirical test, further research should propose a scale to measure innovation ecosystems' life cycle stage and the corresponding coordination level. It is also possible to have new papers exploring case studies on each strategy and life cycle or developing a multiple case study comparing different ecosystems' strategies, among others.

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