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Rediscovering innovation processes in ecosystem settings: the role of ecosystem strategy in shaping new innovation processes

Redescobrindo os processos de inovação em ecossistemas: o papel da estratégia do ecossistema no desenvolvimento de novos processos de inovação

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ABSTRACT

SILVA, L. E. N. **Rediscovering innovation processes in ecosystem settings: the role of ecosystem strategy in shaping new innovation processes**. 2024. Dissertação (Mestrado) – Faculdade de Economia, Administração, Contabilidade e Atuária, Universidade de São Paulo, São Paulo, 2024.

The literature on innovation processes has taken a contingency view of the innovation activity by arguing that the processes of idea generation, selection, development, and diffusion assume unique configurations according to the different contexts, settings, and strategies. More recently, innovation scholars are investigating the notion of ecosystem, which refers to a structure of interdependent, yet dependent actors who collectively work together to materialize the value proposition. Research has shown how new firms moving towards competing via ecosystems are changing their innovation processes to deal with it. However, research on innovation processes in ecosystem settings is still scattered, lacking a theoretical framework that shows how innovation processes occur in ecosystem settings. Additionally, while research provides evidence that strategy affects the innovation processes, we still have limited insights into how a strategy designed to address the ecosystem affects the development of new or the adaptation of existing innovation processes. In this sense, the guiding question of this research is "*what are the contingencies that explain variances of innovation processes in ecosystem settings?".* To address this question, this research seeks to explore the missing link between innovation processes and ecosystems by employing two research methodologies. First, a systematic literature review is conducted to capture insights on the contingencies that explain the variations in innovation processes in the ecosystem and the different types of innovation processes. The main insight from the literature review is that strategy shapes how firms define and deal with multiple innovation processes. Second, based on a survey of 268 individuals involved in the innovation activities of multiple firms, this research explored the link between ecosystem strategy and innovation processes. Based on the confirmation of the 6 hypotheses using PLS-SEM, this research provides an empirical examination of ecosystem strategy as a contingency that explains variations in innovation processes. Finally, this paper provides a discussion of the findings and concludes with limitations and suggestions for future studies to advance the understanding of innovation processes in ecosystem settings.

Keywords: Innovation management, innovation ecosystems, innovation processes, systematic literature review, PLS-SEM.

RESUMO

SILVA, L. E. N. **Rediscovering innovation processes in ecosystem settings: the role of ecosystem strategy in shaping new innovation processes**. 2024. Dissertação (Mestrado) – Faculdade de Economia, Administração, Contabilidade e Atuária, Universidade de São Paulo, São Paulo, 2024.

A literatura sobre os processos de inovação adotou uma visão contingencial da atividade de inovação, argumentando que os processos de geração de ideias, seleção, desenvolvimento e difusão assumem configurações únicas de acordo com diferentes contextos, ambientes e estratégias. Mais recentemente, estudiosos da área de inovação estão investigando a noção de ecossistemas, que se referem a estruturas de atores interdependentes, porém dependentes, que trabalham coletivamente para materializar a proposta de valor. Pesquisas têm mostrado como novas empresas que se movem em direção à competição por meio de ecossistemas estão alterando seus processos de inovação para endereçar esse novo contexto. No entanto, a pesquisa sobre os processos de inovação em ambientes de ecossistema ainda é dispersa, carecendo de um quadro teórico que mostre como esses processos ocorrem nesses contextos. Além disso, enquanto a pesquisa fornece evidências de que a estratégia afeta os processos de inovação, ainda temos *insights* limitados sobre como uma estratégia projetada para lidar com o ecossistema afeta o desenvolvimento de novos processos de inovação ou a adaptação de processos existentes. Nesse sentido, a pergunta orientadora desta pesquisa é "*Quais são as contingências que explicam variações nos processos de inovação em ambientes de ecossistema?*". Para abordar essa pergunta, esta pesquisa busca explorar o elo perdido entre os processos de inovação e os ecossistemas, empregando duas metodologias de pesquisa. Primeiro, é realizada uma revisão sistemática da literatura para capturar *insights* sobre as contingências que explicam as variações nos processos de inovação no ecossistema e os diferentes tipos de processos de inovação. A principal conclusão da revisão da literatura é que a estratégia molda como as empresas definem e lidam com múltiplos processos de inovação. Em segundo lugar, com base em uma pesquisa com 268 indivíduos envolvidos nas atividades de inovação de várias empresas, esta pesquisa explorou a ligação entre a estratégia de ecossistema e os processos de inovação. Com base na confirmação das seis hipóteses usando PLS-SEM, esta pesquisa fornece um exame empírico da estratégia de ecossistema como uma contingência que explica variações nos processos de inovação. Finalmente, este artigo fornece uma discussão dos resultados e conclui com limitações e sugestões para estudos futuros para avançar na compreensão dos processos de inovação em ambientes de ecossistema.

Palavras-chave: Gestão da inovação, ecossistemas de inovação, processos de inovação, revisão sistemática da literatura, PLS-SEM.

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1 INTRODUCTION

Building and managing innovation processes might explain why some firms succeed in their innovation activities while others do not (e.g., Salerno et al., 2015). Innovation management has been centered on the notion that innovation processes assume unique configurations according to different contingencies, such as digital innovation (Appio et al., 2021), and radical innovation (e.g., O'Connor and DeMartino, 2013). For the past thirty years, the innovation management field has been exploring the phenomenon of ecosystems, which moves the locus of value creation from a single firm to a set of independent yet interdependent firms that engage together in a collective value proposition (e.g., Adner, 2017; Jacobides et al., 2018; Stonig et al., 2022). The ecosystem has become an important organizational structure that allows firms to resolve coordination challenges and align interdependent actors (Jacobides et al., 2024). However, the landscape of innovation processes in the ecosystem is still fuzzy, without clear theoretical integration.

The innovation processes are "the sequence of events that unfold as ideas emerge, are developed, and are implemented within firms, across multi-party networks, and within communities" (Garud et al., 2013, p. 774). The literature on innovation processes has explored how different contextual and strategic contingencies shape these processes. For example, by focusing on understanding how firms build innovation processes, Salerno et al. (2015) uncover eight types of innovation processes that are designed according to the projects' contingencies. Indeed, other studies have also shown different configurations in innovation processes for new ventures with high uncertainty (e.g., Townsend et al., 2018), software development, based on agile or hybrid approaches (e.g., Gomes et al., 2022), and radical innovation (e.g., O'Connor and Rice, 2013), among others. Overall, these studies suggest that different contingencies shape unique configurations of innovation processes (Salerno et al., 2015).

Traditional approaches to innovation processes have been closely linked to new product development - NPD. Clark and Wheelwright (1992) built the notion of the innovation funnel to explain how firms begin their processes with an extensive number of ideas that will be refined over a systematic innovation process. Building on NPD as a process, Cooper (1990), elaborated the notion of the stage-gate as a systematic process where managers had specific gates and states to evaluate the innovations and ensure quality. Overall, these traditional approaches were successful in an era where firms were competing via quality (e.g., Cooper, 1994) and the purpose was to ensure that the product was superior to the rivals' (e.g., Wheelwright and Clark, 1992). Strategic management was mainly concerned with industry analysis and exploring how internal resources could be a source of competitive advantage for firms (Hoskisson et al., 1999).

This landscape changed with the concept of open innovation. Chesbrough (2003) introduced the notion of open innovation (OI) in an era of great expansion of research centers and universities. In this landscape, firms were starting to recognize the potential for leveraging external knowledge into their internal innovation processes (e.g., Chesbrough, 2003). The notion of OI became popular, and firms began to modify their innovation processes to deal with open innovation (Majchrzak et al., 2023). For example, research has shown that established firms use cooperate accelerators to engage with innovative startups (e.g., Decreton et al., 2018). While supply chain research was already exploring complex chains of actors, open innovation research has emphasized value creation by exploring the leveraging of external knowledge and firms opening their innovation processes to benefit from this new context (e.g., Chesbrough and Bogers, 2014). Strategic issues in the age of innovation management have shifted from issues of quality to exploring how to facilitate knowledge flows and deal with intellectual property issues, among others (Borges et al., 2019).

The notion of open innovation helped firms recognize the possibilities of distributed innovation processes (Chesbrough and Bogers, 2014). However, a new trend was emerging in the innovation literature. While open innovation was centered on understanding how to manage knowledge flows across organizational boundaries (Borges et al., 2019), innovation research employed the notion of an ecosystem to discuss distributed forms of value creation (e.g., Moore, 1993, 1996). Moore (1993) popularized the term by showing how firms progressively depend on actors outside the firm to create value. The term became popular in the following years in the literature on innovation, strategy, and entrepreneurship (Gomes et al., 2018).

Scholars employed the notion of an ecosystem to explore new forms of value creation (e.g., Adner and Kapoor, 2009), value capture (e.g., Ritala et al., 2013), and competition (e.g., Hannah and Eisenhardt, 2018). Indeed, the terminology became so popular as to drive the emergence of different types of ecosystems (i.e., knowledge ecosystem, entrepreneurial ecosystem, digital ecosystem, and platform-based ecosystem). In an insightful review, Thomas and Autio (2020) organized a typology based on the innovation ecosystem, knowledge ecosystem, and entrepreneurial ecosystem. Each of these has different outputs. The focus of this research is particularly on the innovation ecosystem (hereafter 'ecosystem'), which is defined as “a community of hierarchically independent, yet interdependent heterogeneous participants who collectively generate an ecosystem output” (Thomas and Autio, 2020, p. 38).

A turning point in the ecosystem literature was the notion of structure. Adner (2017) defined an ecosystem as “the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize” (Adner, 2017, p. 40). This insight has led scholars to move the discussion from exploring different facets of the ecosystem concepts to recognizing the strategic implications of framing the ecosystem as an alignment structure. Indeed, Adner (2017) argues that the ecosystem strategy refers to how firms will pursue this alignment. Building on this, Gomes et al. (2023) advocate for the existence of two types of strategy, an ecosystem-based strategy where the firm wants to guarantee its role in the ecosystem, and an ecosystem strategy where the goal is to guarantee the success of the ecosystem competing with rivals (Gomes et al., 2023). Indeed, the notion of competition within and across ecosystems is central to understanding its dynamics (e.g., Hannah and Eisenhardt, 2019; Rietveld and Schilling, 2020). Despite the evolution, the ecosystem literature has grown fragmented and the systematic understanding of how innovation processes occur in these settings remains limited. While scholars have shown how firms manage ecosystems to enable collective value creation (Gomes et al., 2022), we have a limited understanding of how innovation processes were modified in this context (in line with the contingency perspective).

The current literature provides insights into firms building new processes to create an ecosystem (e.g., Jacobides, 2022; Stonig et al., 2022), to govern the ecosystem’s activities (e.g., Rietveld, 2020), and to increase value creation within the ecosystem (e.g., Cennamo and Santaló, 2019). Despite this strategic shift in the firm’s innovation activities, the innovation literature is still underdeveloped in providing an integrative view of the contingencies brought by the ecosystem and how they affect the development of new innovation processes. For example, the ecosystem brings new features that firms aiming to succeed in building an ecosystem need to fully understand (Jacobides et al., 2023). However, the literature is still lacking an integrative framework explaining how firms operating in an ecosystem transform their innovation processes according to different features of the ecosystem. Furthermore, we still do not understand how firms strategically deal with innovation processes in ecosystem settings. Understanding how to organize and manage innovation processes in ecosystem settings may be the key to succeeding in an age where competition moves from firm vs firm to ecosystems vs ecosystems (e.g., Apple Music vs Spotify; Android vs iOS).

Overall, despite progress, the understanding of innovation processes in ecosystem settings remains problematic. First, while ecosystem literature has expanded over the past decades, we still have limited integrated insights into how innovation processes occur in ecosystem settings. An increasing body of research is exploring how firms moving from integrated value propositions based on ecosystems are transforming their existing innovation processes (e.g., Stonig et al., 2022; Jung, 2023) and creating new processes to address the ecosystem (e.g., Thomas et al., 2022). Additionally, researchers are exploring how firms in different ecosystem positions and roles need to develop new innovation processes (e.g., Ganco et al., 2020; Jung, 2023). For example, Ganco et al. (2020) show that firms in different positions within the ecosystem pursue different search strategies. Beyond the position, complementors and ecosystem leaders also differ in their innovation processes. For example, while the orchestrator deals with the definition of the platform's architecture, governance structure, and unleashing the ecosystem's value creation (Inoue, 2021), the complementor needs to make sense of the ecosystem's structure and adapt their processes and decision-making processes to address the ecosystem's rules (Cenamor, 2021).

Second, there is a need for a greater understanding of how the contingencies brought by the ecosystem have changed the innovation processes of firms operating in ecosystems. The innovation management literature has moved to an understanding of the contextual nature of innovation processes and recognizes that different contingencies require variations in the innovation processes (Ott and Van Der Duin, 2008). Research shows that firms competing via radical innovation need to establish unique processes and structures to develop radical innovation (e.g., O'Connor and Rice, 2013). For example, these firms employ more flexible processes based on experimentation (Colombo et al., 2017). Similarly, researchers are illustrating how ecosystems change the dynamic of innovation management (Ganco et al., 2020).

Third, there is a lack of research exploring how firms competing in the ecosystem change their innovation processes given the new strategy. The literature has shown that firms employ different strategies when dealing with ecosystems (Gomes et al., 2023; Hannah and Eisenhardt, 2019; Kretschmer et al., 2022; Rietveld et al., 2019; Rietveld et al., 2021). Additionally, we have insights that firms competing via ecosystem create unique mechanisms to guide the partners and trigger their systemic innovations (e.g., Rietveld et al., 2019). For example, a key discussion in the platform scholarship is how firms use boundary resources strategically both to facilitate the innovation of other ecosystem partners and also to trigger the expansion of the ecosystem (e.g., Inoue, 2021). Furthermore, Gomes et al. (2023) have uncovered the dynamics of firms that need to deal with competing and often contradictory strategies; however, we still do not have a clear understanding of how these strategies trigger the emergence of new or adapted innovation processes to address them.

Aiming to address these gaps, this research's is guided by two main questions: *what are the contingencies that explain variances of innovation processes in ecosystem settings?* and *how do strategies in ecosystems shape innovation processes in ecosystems?* To explore these questions, this research proposes to explore the missing link between innovation processes in ecosystem settings by uncovering the new contingencies that shape the innovation processes of firms competing in ecosystem settings and exploring how ecosystem strategy affects the emergence of new processes. More specifically, this research aims to:

1) Systematically review the literature on innovation processes in ecosystem settings to identify the different contingencies that drive variations in innovation processes;

2) Categorize the set of innovation processes in ecosystem settings;

3) Examine the effect of ecosystem strategy in the development of innovation processes in ecosystem settings;

1.1 Theoretical Contributions

This research adds to the current scholarship exploring how firms competing via ecosystem need to move beyond strategic positioning to develop specific processes to create (e.g., Stonig et al., 2022; Thomas et al., 2022), manage (e.g., Gomes et al., 2022), govern (e.g., Rietveld, 2020), nurture (e.g., Schreieck et al., 2021), and trigger innovation in ecosystems. This research provides five main contributions to the literature. This research contributes to the literature in three aspects:

First, innovation management literature has recognized the role of specific contingencies shaping the innovation processes, however, few studies have taken an ecosystem perspective to explore how new contingencies affect the variations of innovation processes in ecosystem settings. In this sense, this research contributes by adding to the extensive research on innovation processes (Garud et al., 2013; Salerno et al., 2015), an ecosystem perspective by uncovering the key contingencies that provoke variations in the innovation processes.

Second, research on innovation processes in ecosystem settings has remained mostly fragmented, with a pressing need to integrate the multiple streams of research. Particularly, existing research provided an initial understanding of the innovation dynamics within ecosystems (Ganco et al., 2020; Jung, 2023), however, research was still in need of a conceptual framework that provided an integrative perspective on innovation processes in ecosystem settings. This research provides an integrative framework by uncovering three dimensions of innovation processes in ecosystems and a construct that explains how managers deal with these processes (i.e., the innovation processes regulation). By providing this integrative framework, future scholars can build upon this research to explore more deeply the dynamic of innovation management within ecosystems.

Third, while we had knowledge of the different strategies in ecosystem settings (e.g., Gomes et al., 2023), we had limited insights into how these specific strategies had led to different innovation processes. For example, Rietveld (2020) shows that the dynamic of ecosystem governance shifts as the ecosystem evolves, with the leaders becoming progressively dominant. Additionally, Hannah and Eisenhardt (2019) uncovered how firms shift their strategies to address different issues within the ecosystem. Despite this initial evidence, existing scholarship is still scarce regarding how ecosystem strategy is a contingency that provides variations in the innovation activity (i.e., the innovation processes). From this perspective, this research contributes by providing an empirical examination of how strategy within the ecosystem affects the development of new innovation processes. Beyond providing an empirical examination, this research provides a reliable and valid scale that can be further employed by ecosystem scholars to explore new constructs and open the black box of innovation processes in ecosystems.

1.2 Managerial Contributions

A key issue that innovation management literature tries to provide insights into is resource allocation (Brasil et al., 2018). Managers are interested in understanding where to better allocate their resources to trigger and facilitate innovation development. While a significant stream of research has provided insights into resource allocation for incremental or radical innovation, among others, research remains largely limited to exploring how firms can better improve their resource allocation in ecosystem settings. A notable exception is Adner and Feiler (2019), which investigated how investors perceive and assess risk in interdependent settings.

Firms competing in ecosystem settings face great challenges in dealing with complex strategic issues such as value capture vs value creation and battles for ecosystem leadership, however, without properly recognizing how innovation processes take place in ecosystem settings, firms might fail to recognize how to appropriately allocate resources into these processes to ensure a successful development of the ecosystem. In this perspective, this research can guide managers into recognizing that: 1) strategies in the ecosystem are complex and require a unique set of innovation processes, 2) innovation processes in ecosystem settings assume unique characteristics according to the different contingencies such as the ecosystem structure and competing and collaborating with autonomous partners, 3) the new approach to strategy in ecosystem settings trigger a new set of innovation processes.

The new competition based on the ecosystem has brought new strategic issues to managers, who need to learn how to play this new game with new rules of competition (e.g., Adner, 2021). This research provides an initial framework and empirical evidence that can guide managers in this complex and uncertain phenomenon.

1.3 Organization of the dissertation

This dissertation is structured in two main parts. First, the systematic literature review was used to categorize and identify the innovation processes in ecosystem settings. Then, the results from the systematic review were used in an empirical quantitative research testing the relationships between strategies and innovation processes. Together, the two research methods conducted complement the understanding of innovation processes in ecosystem settings.

The dissertation is organized as follows: In the next section, I will present the theoretical background covering the literature on innovation processes and ecosystem management. The subsequent section introduces the methodology for conducting a systematic review of innovation processes in ecosystem settings. In the following section, the findings from the systematic review are presented, including the typology of innovation processes in ecosystem settings and a new framework. The fourth section discusses the theory and hypotheses for the structural model, followed by a description of the methodology used to empirically test it. The subsequent section presents the findings from the empirical research, which are then discussed. Lastly, the dissertation concludes with final remarks, highlighting the main findings, conclusions, limitations, and potential for future studies.

2 THEORETICAL BACKGROUND

This section presents the theoretical background of the research, particularly discussing the innovation processes and ecosystems. The theoretical framework that guides this research goes beyond this section and is also composed of the systematic literature review and the section on "theory and hypothesis development" (Figure 1).

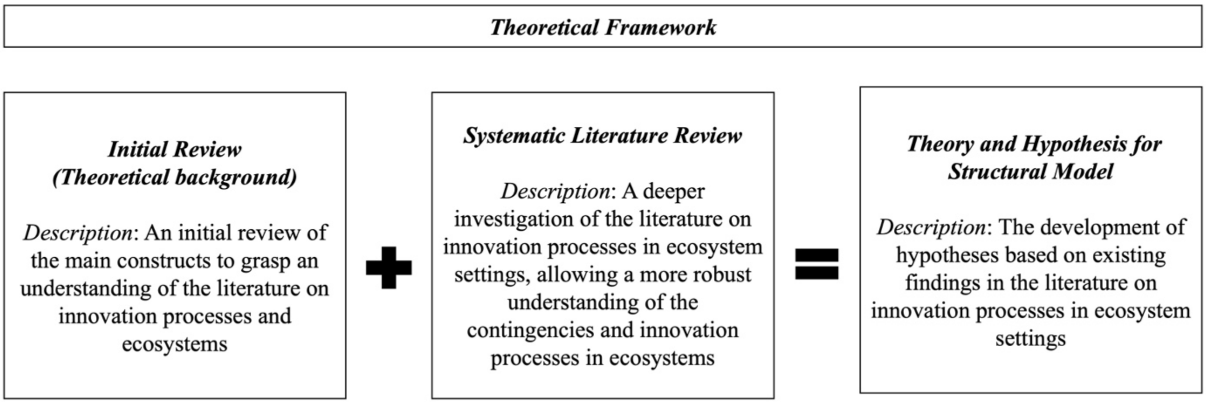

Figure 1. Theoretical framework

2.1 Innovation Processes

Traditionally, innovation processes have been discussed as a sequence of phases from the conception of ideas to their release in the market (Salerno et al., 2015). Garud et al. (2013) reviews the literature on innovation processes and define them as the sequence of activities from the development of ideas until the diffusion of these ideas in the market. Despite traditionally being recognized as a sequence of phases, scholars have called for a contingency perspective of innovation processes (e.g., Ortt and Van der Duin, 2008; Salerno et al., 2015). Indeed, traditional innovation management approaches have introduced normative ideas of how firms should manage their innovation processes, however, now there is an understanding that innovation management is moving towards exploring how the specific context of firms is affecting the development of innovation processes (Ortt and Van der Duin, 2008). From this perspective, it is important to highlight the most critical contributions to innovation management literature and explore how innovation processes have moved towards a contingency perspective.

The primary focus of innovation management has traditionally revolved around New Product Development (NPD). Early studies aimed to understand how to enhance and organize NPD processes. In 1992, Wheelwright and Clark introduced the concept of the "funnel" to explore how ideas initially start as complex and diverse but are subsequently refined through a systematic development process. In line with the objective of improving NPD, Cooper (1990) introduced the concept of "stage-gate systems," emphasizing that product innovation is a manageable process. By applying process-management methodologies to the innovation process, stage-gate systems enable effective management of innovation (Cooper, 1990, p. 45). The main idea of the stage-gate was to divide the innovation processes into a set of distinct stages, each with predefined activities with a gate that acts as a checkpoint to control the quality (Cooper, 1990).

These approaches to innovation processes were mostly centered on the firm. This changed with Cheresbrough`s (2003) introduction of the notion of open innovation. Chersbrough (2003) argues that the traditional approach to innovation management (i.e., the closed innovation paradigm) based on organizing industrial R&D resulted in many achievements, however, in the landscape of the twenty-first century based on knowledge, the paradigm was becoming displaced. Open innovation is, therefore, a way for firms to explore knowledge diffusion and leverage this knowledge to improve value creation (Chesbrough, 2003). Recent research explores the benefits of firms engaging in open innovation relationships and enhancing value capture (e.g., Majchrzak et al., 2023). For example, Faridian and Neubaum (2021) show how established firms can benefit from the engagement with startups via exploitation-oriented ties, while startups benefit from exploitation-oriented ties via asset sharing and these assets are fundamental to budling intrapreneurial capabilities (Faridian and Neubaum, 2021).

The open innovation approach was particularly useful in an age where firms were progressively seeking more radical innovation as a source of competitive advantage (McDermott and O'Connor, 2002). In this context, innovation activities became more complex due to the uncertainty inherent in radical endeavors. Different from incremental, radical innovation moves beyond existing products, processes, business models, and capabilities (Salerno et al., 2015). Firms that dominate traditional approaches for managing incremental innovation, for example, using the stage-gate approach, face difficulties in managing radical innovation since a unique set of challenges emerge (McDermott and O'Connor, 2002).

Different from risk, in which probabilities are known, uncertainty brings new challenges because managers can predict neither the outcomes nor the trajectory of the innovation using probabilities (in line with Knight, 1921). In this sense, new approaches need to be employed to manage radical innovation. O'Connor (1998) argues that the processes for radical and incremental innovation differ drastically, and firms employ unique mechanisms related to learning and reduce uncertainty. Indeed, aligned with a contingency perspective, what became clear is that practices that are appropriated for managing incremental innovation might be unsuitable for more radical ones (O'Connor, 1998).

Beyond uncertainty, scholars have been arguing that innovation is moving towards collective arrangements where firms depend upon the contribution of external actors (e.g., Moore, 1993). The notion of the ecosystem has been central to the innovation, entrepreneurial, and strategy literature (e.g., Gomes et al., 2018). However, the linkages between innovation processes and ecosystems became fragmented over time.

2.2 Ecosystem Management

The notion of "ecosystem" to explain the collective arrangement of innovation has become popular over the last decades in management, entrepreneurial, and strategy research (e.g., Thomas and Autio, 2020). The "ecosystem" was first introduced as a metaphor by Moore (1993). The author argues that within a business ecosystem, companies "work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations". This first definition of the ecosystem in the strategy literature borrowed the term from biology intending to discuss a new environment for the development of innovation that crosses multiple industries. Furthermore, this initial definition using an ecological perspective highlights that ecosystems evolve (i.e., birth, expansion, leadership, and self-renew), thus bringing different strategic challenges in each maturity phase.

Over the past decades, the ecosystem has experienced a myriad of definitions and theoretical experimentation (e.g., Gomes et al., 2018). For example, multiple authors have explored variations in ecosystems (e.g., innovation ecosystem, business ecosystem, knowledge ecosystem, entrepreneurial ecosystems, and digital ecosystems). More recently, Gomes et al. (2021a, p. 7) argue for the development of ecosystem management as a legitimate research field and define an ecosystem as "(1) a meta-organization (2) composed of a set of heterogeneous, independent, yet interdependent actors (3) bounded by complementarities, (4) which collectively generate a systemic innovation by combining their individual offerings in a coherent manner (5) for a targeted audience." This definition highlights the most important features of the ecosystem: the set of actors (with different backgrounds), the alignment structure, the complementors, the focal value proposition (a systemic innovation), the ecosystem level output (better than what an individual company could generate) and the targeted audience (the ecosystem is focused on proposing value for a defined target).

Concept	Definition
Innovation Ecosystem	"a community of hierarchically independent, yet interdependent heterogeneous participants who collectively generate an ecosystem output" (Thomas and Autio, 2020, p. 38).
Knowledge Ecosystem	"Organizations comprising diverse actors bound together by a joint search for valuable knowledge" (Jarvi et al., 2018, p. 1524).
Entrepreneurial Ecosystem	"A regional community of hierarchically independent, yet interdependent heterogeneous participants who facilitate the start-up and scale- up of entrepreneurial new ventures who compete with innovative business models" (Thomas and Autio, 2020, p. 38).

Table 1. Different types of ecosystems

Gomes et al. (2021) introduce the literature on ecosystem management in three stages: building, experimenting, and understanding. The first phase is the understanding of the ecosystem as a metaphor that helps in explaining how the development of innovation is dependent on other actors. The second phase, experimenting, comprises papers that explored this metaphor and it was the stage for the proliferation of concepts (i.e., business ecosystem, knowledge ecosystem, innovation ecosystem. The third phase (current) is a result of a shift in the understanding of the ecosystem, now as structure. Thus, the focus on the alignment structure of partners (Adner, 2017) is a turning point for this literature. New research can now use the approach of interdependence to explore issues of performance between ecosystems, and competition and adapt previous theory to this new level of analysis (Adner, 2017; Gomes et al., 2021a).

In this sense, recent scholarship in the ecosystem has investigated previously known issues in management research with a new lens of innovation research. Hannah and Eisenhardt (2018) investigating the ecosystem of the US solar power industry highlights how the firms navigate between competition and cooperation. The authors found different strategies to manage coopetition in different stages of the development of the ecosystem and highlighted the need to manage value capture and value creation in the ecosystem. Gomes et al. (2020) discuss the phenomenon of uncertainty propagation, recognizing that inside the innovation ecosystem, uncertainty can be collective (affecting different actors) and propagated both intentionally and unintentionally.

A significant advancement in ecosystem literature is positioned as an answer to the requests for better explanation and theorization of the ecosystem, the notion of the ecosystem-as-structure approach (Adner, 2017; Jacobides et al., 2018). Adner (2017, p. 40) invites scholars to investigate the ecosystem as "the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize". The ecosystem structure (Figure 2) represents the set of activities, positions, actors, and links that need to be aligned for the materialization of the systemic value proposition (Adner, 2017; Adner and Kapoor, 2010). The notion of structure allowed scholars to move from the experimentation of different concepts (see. Gomes et al., 2022) to explore how value is created within this alignment structure (e.g., Ganco et al., 2020).

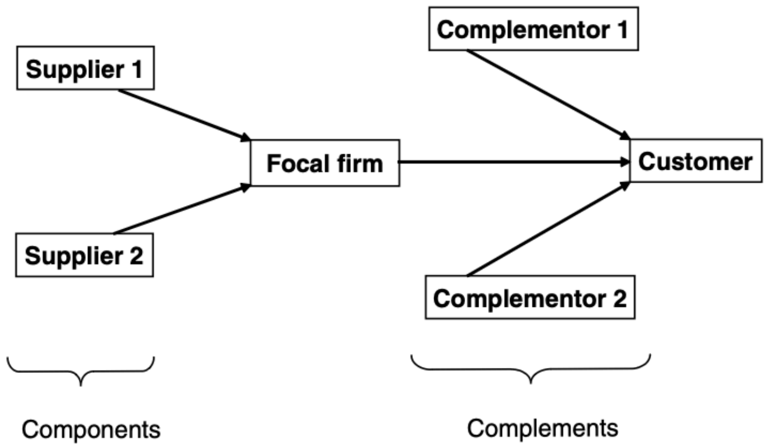

Figure 2. Structure of a generic ecosystem
Note. Source: Adner and Kapoor (2010)

In this sense, Ganco et al. (2020) were the pioneers in linking the ecosystem structure to innovation processes. The author investigated the search process and found that actors in different positions within the ecosystem search for innovation differently (Ganco et al., 2020). Interestingly, the paper provides empirical evidence of how complementors' position as upstream firms (i.e., providing components) and downstream (i.e., providing complements) shape the way these companies develop innovation. To increase the innovativeness of these companies, the management of innovation can play a very significant role. Linked to the notion of contingency, Ganco et al. (2020) illustrated how firms competing via ecosystem transform their innovation processes.

In a similar perspective, Jung (2023) provides another insightful case. In investigating Oracle's platform, the author found that after entering the ecosystem, the members transform their innovation search to address competitive challenges (Jung, 2023). Indeed, the author found that when joining the platform, the complementor increases its search not only to Oracle's platform but also to its rivals in order to reduce the competitive threats of the focal company (Jung, 2023). Different from Ganco et al. (2020), Jung (2023) illustrates that beyond the position, the role in the ecosystem also provokes variations in the innovation processes.

Together, this body of work illustrates that: 1) the ecosystem has become a prominent structure for value creation, 2) firms operating within the ecosystem modify their innovation processes, and 3) multiple elements of the ecosystem structure and competition within the ecosystem drive modifications in the innovation processes.

2.3 Strategies and innovation processes in ecosystem settings

Strategizing in ecosystem settings is a complex and often conflicting endeavor (Gomes et al., 2023; Rietveld and Schilling, 2020; Schereick et al., 2023). Firms in the ecosystem face the great challenge of dealing with competition within the ecosystem (i.e., complementors and orchestrators) and between ecosystems (e.g., ecosystem and rival ecosystem) (Gomes et al., 2023; Kretschmer et al., 2022).

Traditionally, strategy in ecosystem settings has taken the perspective of the orchestrator to explore how they establish and sustain leadership in the platform (e.g., Foss et al., 2023), how they establish governance and control mechanisms (e.g., Rietveld, 2020), and how they create mechanisms to guide the complementors in creating value (e.g., Inue, 2021). Recently, scholars have divided the strategies for growth and strategies for competition. The strategies for growth are concerned with dealing with the issues of attracting new members to the ecosystem, while the strategy for competition. Deals with strengthening the competition of the ecosystem in comparison to other platforms (Schereick et al., 2023).

In an insightful study, Gomes et al. (2023) argue that there are two strategies in the ecosystem (in line with Adner, 2017): the ecosystem-based strategy and the ecosystem strategy. The *ecosystem-based strategy* represents "a set of activities by which a firm pursues creating an advantage, secures its role, and succeeds in a particular ecosystem" (Gomes et al., 2023, p. 544). This type of strategy has its locus in the firm deals with a critical notion of coopetition within the ecosystem (e.g., Hannah and Eisenhardt, 2019).

The *ecosystem strategy* represents "a set of activities by a group of autonomous yet interdependent actors that deliver a value proposition to clients attempting to create advantage and succeed against rival ecosystems" (Gomes et al., 2023, p. 544). This type of strategy recognizes how the focal firm can only shape the activities of the complementors and represent the efforts to guarantee a superior value output in comparison with rival ecosystems (Gomes et al., 2023).

Gomes et al. (2023) investigate how the performance measurement and management of firms operating ecosystems are designed to address these strategies. Similarly, this research argues that the innovation processes are shaped by ecosystem strategy (Gomes et al., 2023; Rietveld and Schilling, 2020; Schereick et al., 2023). However, we have limited insights into how strategy in the ecosystem shapes the development of new innovation processes.

Overall, the ecosystem provides a unique setting to understand how innovation processes take place. While the current literature has provided insights into how firms are developing new or adapting existing innovation processes to address the ecosystem, we still lack an integrative theory on what are the contingencies that explain the variation in the innovation processes, and even more importantly, we are experiencing increasing evidence on a myriad of innovation processes that firms competing via ecosystem are developing to create ecosystems, to renew ecosystems, and to trigger innovation in the ecosystem. Despite these key insights, researchers still fail to grasp the complexity and diversity of innovation processes in ecosystem settings without a proper organizing typology and framework.

3 METHODOLOGY FOR THE SYSTEMATIC LITERATURE REVIEW

3.1 Research Design

Like other studies (Altman et al., 2022; Delgosha et al., 2021; Eggers and Park, 2018; Patriotta, 2020; Post et al., 2020; Saebi et al., 2019), we employed a systematic literature review. This strategy allowed us to effectively synthesize the literature landscape of innovation processes in ecosystem settings (from 1993–2022) to present evidence-based results that can enlighten new theoretical developments (Snyder, 2019) and suggest avenues for future research (Davis et al., 2014). Thus, we employed a well-structured approach for the selection and analysis of research papers. Careful and systematic processes contributed to generating new theoretical developments emerging from previously disconnected, dispersed, and fragmented pieces of the literature on innovation processes and ecosystems (in line with Post et al., 2020).

This structured approach for the systematic literature review comprised four macro-phases (in line with Patriotta, 2020): (1) data selection and collection, (2) topic modeling analysis and bibliometric analysis (Delgosha et al., 2021; Kumar and Srivastava, 2022), (3) coding (Dzhengiz and Hockerts, 2022; Furrer et al., 2008), and (4) synthesis (Hopp et al., 2018). The first phase consisted of building our database of articles. As we explain in Section 3.2, we employed a well-structured and transparent process for selecting and collecting articles. Second, we focused on finding the latent topic structure in the literature on innovation processes and ecosystems. We provided an insight that explains and problematizes the current research landscape on innovation processes and ecosystems. The next step corresponded to examining how scholars addressed the innovation processes in the context of ecosystems. We then identified four additional insights and offered potential theoretical ways to integrate these two disconnected fields. Together, these five insights contributed to the development of a new theoretical framework and the identification of future research avenues for the growth of the field. Figure 3 presents a complete roadmap of our systematic literature review.

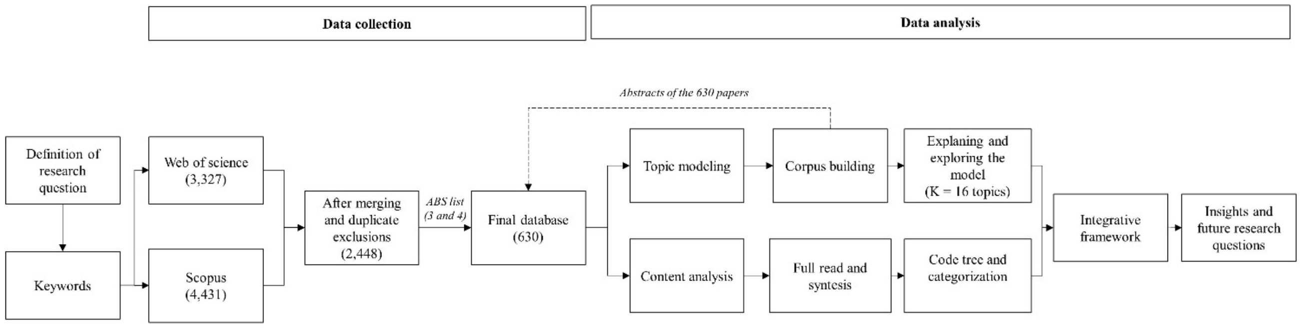

Figure 3. Methodological Framework

3.2 Data Collection/Sampling

In line with Hiebl (2021), our data collection and sampling processes were (1) well-structured, (2) comprehensive in covering the relevant literature, and (3) provided a transparent overview of the steps undertaken in the review. We began by developing a list of literature review search terms. After analyzing recent reviews on ecosystems (Altman et al., 2022; Gomes et al., 2021; Thomas and Autio, 2020) and innovation processes (Bagno et al., 2017; Garud et al., 2013), we generated a comprehensive list of keywords: *("innovation ecosystem*" OR "business ecosystem*" OR "platform ecosystem*" OR "platform-based ecosystem*" OR "entrepreneurial ecosystem*" OR "entrepreneurship ecosystem*" OR "knowledge ecosystem*" OR "digital ecosystem*") AND ("innovation process*" OR "innovation*" OR "search" OR "selection" OR "development" OR "diffusion" OR "implementation")*. We then gathered the data for the review from the Scopus and Web of Science databases to ensure the comprehensiveness of our sample of articles. We conducted the data extraction on July 7, 2022, covering articles from 1993–2022 and including the seminal article by Moore (1993).

This systematic search strategy allowed us to capture how the innovation process was addressed in the extensive ecosystem literature. Given the scope of these topics and the exponential growth of ecosystem literature in recent years (Thomas and Autio, 2020), we used some approaches to refine our initial search. Similar to other reviews (Altman et al., 2022; Gomes et al., 2021), we focused only on peer-reviewed "articles" and "reviews." Further, we selected papers in the areas of "management," "business," "engineering industrial," "operations research," "management science," and "economics." The search resulted in 2,448 papers (after merging the documents from both databases and exclusion of duplicates). We filtered these papers based on the journals classified as 3 and 4 in the Charted Association of Business Schools – ABS (in line with Saebi et al., 2019). Similar to Saebi et al. (2019), we adopted this criterion to focus on papers published in academic journals of quality that had undergone a rigorous peer review process. We then read the abstracts, coded them, and defined whether the papers fit the purpose of our study and addressed innovation processes in ecosystem settings. Through an exhaustive process, we coded 630 papers as highly relevant in our sample.

3.3 Data Analysis

3.3.1 Topic Modeling and Bibliometric Analysis

First, we conducted a bibliometric analysis to map the landscape of the field. We performed a "keyword network" analysis using VOSviewer (Van Eck and Waltman, 2010). Scholars (Chabowski et al., 2022; Mukherjee et al., 2022) argue that bibliometric techniques provide an overview of a science field, which is useful for analyzing trends and providing evidence into the evolution of a research field to advance the theory. Thus, the "keyword network" analysis provided us with an initial overview of the field and the topics; we then proceeded to topic modeling.

Recent research has recognized a myriad of new and powerful tools to analyze a large amount of data. One such tool is topic modeling (Clement and Crutzen, 2021; Han et al., 2021; Kimpimäki et al., 2022; Lu and Chesbrough, 2022; Yun et al., 2021). Topic modeling is an unsupervised machine learning technique to find latent structures within a large corpus of data (Blei, 2012). This approach is powerful in dealing with many unclassified texts (Alghamdi and Alfalqi, 2015) and has recently been employed in systematic literature reviews to analyze the thematic landscape of research streams (in line with Hopp et al., 2018; Kumar and Srivastava, 2022). Indeed, the use of these techniques in systematic reviews is particularly useful since "topic modeling can be automated, substituting the use of the researcher's time with the use of computer time" (Asmussen and Møller, 2019, p. 2).

There are multiple techniques and algorithms to conduct topic modeling, each built with specific goals and treating the analysis differently. The primary algorithms are: (i) latent dirichlet allocation (Blei et al., 2003), (ii) correlated topic modeling, and (iii) structural topic modeling (STM; Roberts et al., 2019). In line with Park et al. (2018), we employed STM. The STM design is well-suited to conduct a systematic literature review (Kumar and Srivastava, 2022), especially as it allows the model to consider the information of metadata present in the papers (Chen et al., 2022; Roberts et al., 2019). For example, the researcher can input information about the publication year or journal to analyze the topics alongside these variables and increase the relevance of the results (Roberts et al., 2019). Like the other topic modeling approaches, STM categorizes each document within K number of topics, and each of these topics is composed of a collection of words with different probabilities (Sharma et al., 2021).

We followed guidelines in agreement with previous studies (Asmussen and Møller, 2019; Denny and Spirling, 2018; Kumar and Srivastava, 2022) that enabled us to build our corpus. Later, we performed all the topic modeling steps using R (through the environment of RStudio) and the STM Package (Roberts et al., 2019). It has been explicitly designed for social science research to allow metadata insertion within the model. The first step of the topic modeling was corpus cleaning. We exported all the metadata from the articles to a ".csv" file format and imported it into the RStudio environment for analysis. Next, the software performed topic modeling using the corpus from the abstracts of the texts, as it allows a more direct and objective view of the paper and its themes (Delgosha et al., 2021). We conducted all the procedures for corpus cleaning using the "tm_map" function from the TM package (Roberts et al., 2019). Moreover, we followed the mandatory processes, aiming for the correct execution of the "tm_map" function. These were: (i) transformation of all words to lowercase; (ii) removal of common stop words (i.e., "we," "also," "and," "however," "thus," and further words that did not add any significance to the text corpus in respect to the topics); (iii) exclusion of numbers and punctuation; (iv) elimination of words with less than three characters; and (v) exclusion of custom stop words, commonly found in abstracts that also did not contribute to our corpus (i.e., "abstract," "article," "paper," "research," and "summary"). This allowed us to clean the corpus and ensure that only the relevant material was used to perform the analysis.

After creating the text corpus for analysis, the subsequent step for topic modeling consists of defining the number of topics (K). There are multiple ways to establish the number of topics (Park et al., 2018; Roberts et al., 2019). Despite being a computer-based analysis, the model requires the prior establishment of several topics (Chen et al., 2022). Though there are multiple criteria to evaluate the number of topics, most researchers agree that peer evaluation is still the best indication (Asmussen and Møller, 2019). We validated K using two methods: (1) semantic coherence and exclusivity and (2) expert opinion. Semantic coherence estimates the consistency of the topics in a given interval (Roberts et al., 2019). We performed an analysis of the semantic coherence using 10–50 topics. The analysis highlighted that semantic coherence could be maximized between 15–20 topics. This process ensured that the words from each topic were exclusive to them, and each topic represented a unique set of words. Next, we performed an iterative process to build the exact number of topics and showed them to experts in the area.

Although we built multiple models, the experts agreed that 16 was a suitable number of topics as it represented the literature we were investigating.

The output of the topic modeling is the distribution of topics in the sample and the keywords that represent the topic (Park et al., 2018; Roberts et al., 2019). The program showed the 16 topics with the different words associated with these topics (i.e., topic 1: innovation, ecosystem, firms, open, business, knowledge, firm, model, network, and SMEs). Since topic labeling requires a manual definition, the first stage after the model's output is to label the topics. We used the function *FindThoughts* in R to explore the most representative papers on each topic. In line with Kumar and Srivastava (2022), we analyzed the 10 most important papers to label the topics through an iterative process of discussions to find the most suitable label for the 16 topics. Further, we analyzed each individual topic, the words from each topic, and the papers that were categorized within each topic (Table 2). This process followed an iterative logic of using the content from the topics to build a robust and systematic interpretation and label the topics. This labeling process was performed by one author, and then discussions were held with all the authors to find the most suitable labels that represented the 16 topics identified in the literature.

The last step in the topic modeling analysis is the synthesis of the results and additional analyses that the researchers wished to perform. We first created Table 2, which presents the topics, the words from each topic, the label, the temporal range, and the most cited papers from each topic. This table allowed us to analyze the literature in a structured manner and provided insights into the landscape of the ecosystem and innovation process field. Additionally, we correlated the topics with the 0.1 cutoff (Cohen, 1992) to find possible points of connection among the different topics (Chen et al., 2022). This cutoff is a specific threshold measure that allows us to maintain only the relevant connections among the topics; thus, we consider that if "two topics are correlated above that threshold, then those two topics are considered to be linked" (Roberts et al., 2019, p. 24). The correlation is useful to find whether different topics are discussed within the same document. Topic correlations were created using the R package "huge" (Zhao et al., 2012). The correlation of the topics was used to build a topic network which showed the relationships among the topic landscape graphically (Roberts et al., 2019). Similar to Hopp et al. (2018), we analyzed both the topic landscape (Table 2), the topic network (Figure 2), and the keywords network (Figure 3) to gather insights from the literature.

3.3.2 Coding

Like other reviews (Gomes et al., 2021; Thomas and Tee, 2021), we used coding to determine how innovation processes occur in ecosystem settings. Although iterative, we identified four main phases based on the work of Corbin and Strauss (2008): (i) creating an initial understanding of the how and why of variations in innovation processes in the ecosystem, (ii) developing an initial typology of innovation processes, (iii) identifying the interplay between different types of innovation processes in ecosystems, and (iv) proposing a new framework of innovation processes in ecosystems.

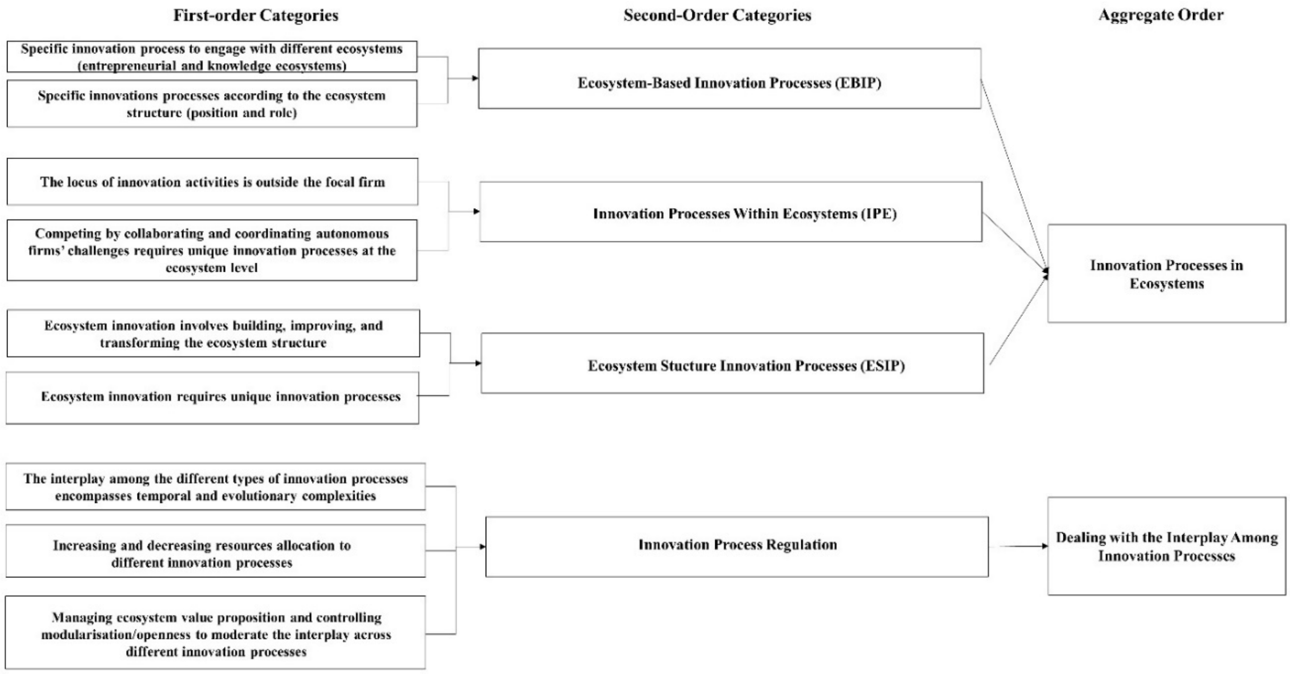

Figure 4. Data Structure

We began by coding variations on the innovation processes and their constitutive themes (e.g., search/idea generation, development). To organize our coding process (data structure is presented in Figure 4), we started by coding the most cited papers on each topic (based on the topic modeling). Our research team then came out with a shared understanding that innovation processes in ecosystems presented a relevant set of unique activities and challenges in relation to prior research. Subsequently, based on the extant research on innovation processes (Garud et al., 2013; Salerno et al., 2015), we searched for potential coding contingencies that could explain such variations (in terms of activities) in innovation processes. Through an iterative process, we identified an initial list of candidates: ecosystem structure, engagement with different types of ecosystems, and innovating the ecosystem structure. We then read the rest of our sample to improve our understanding of potential contingencies and new activities related to innovation processes in the ecosystem. Further, we identified a fourth contingency related to the firm's decision to compete by collaborating and coordinating with autonomous actors.

Later, we began by assembling activities to understand how each contingency led to a unique configuration of innovation processes. For example, we coded activities that differentiate innovation processes in orchestrators and complementors. We then developed an initial categorization of innovation processes in ecosystems: *ecosystem-based innovation processes*, *innovation processes within the ecosystem*, and *ecosystem structure innovation processes*. We organized internal meetings in which we presented such categories, inductively classified papers according to this category, and discussed empirical examples (from our sample) to illustrate each category. We also organized workshops with non-involved researchers to present our findings and typologies. These workshops contributed to improving the quality of our research and refining our results.

Our next step consisted of coding the interplay between the different types of innovation processes in the ecosystem. Building on prior research (Garud et al., 2013; Gomes et al., 2022; Thomas and Autio, 2020), we identified that these codes were related to important complexities: evolutionary (co-evolution) and temporal. We then examined how firms address such complexities. We elaborated on the notion of orchestration (Dattée et al., 2018; Gomes et al., 2022; Thomas et al., 2022) to develop the "*innovation process orchestration*" approach.

Finally, we organized our results into five insights and elaborated and built on these insights to develop a new framework (Figure 5). We also compared our findings with prior approaches for innovation processes to remark on the unique, complementary nature of our findings. Moreover, we examined our sample and findings to identify potential questions and directions for guiding future research.

4 INNOVATION PROCESSES IN ECOSYSTEM SETTINGS: A SYSTEMATIC LITERATURE REVIEW

The following section presents the key insights derived from our bibliometric analysis and coding of the landscape regarding the intersection between innovation processes and ecosystems. Based on the analysis of 630 research articles using topic modeling, we found one initial evidence-based insight that highlights the fragmentation regarding the intersection between innovation processes and ecosystem fields and addresses crucial issues and problems regarding this intersection. Building on the coding of our sample, we derived four evidence-based insights that provide the basis for new theoretical developments. The insights build on and go beyond the current scholarship by providing a new typology of innovation processes in ecosystems and a new framework for innovation processes in the ecosystem (Figure 3).

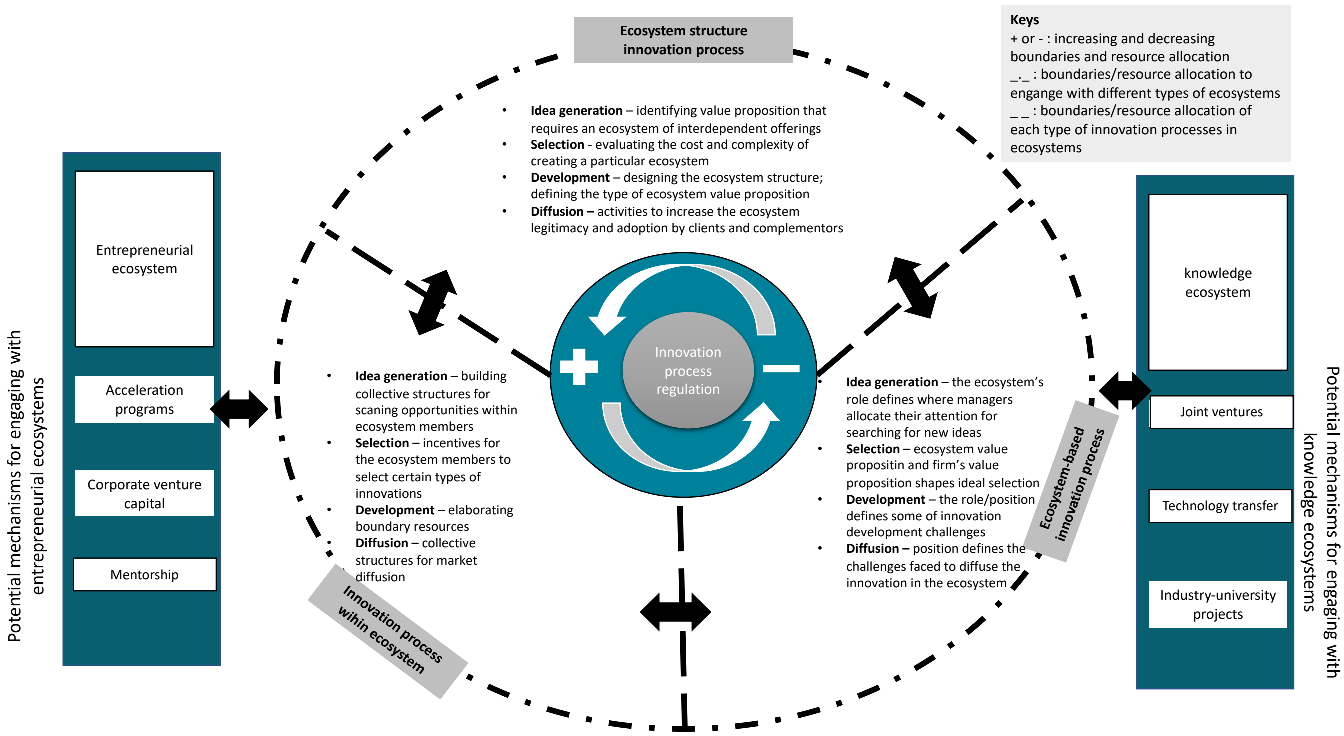

Figure 5 - A new framework: innovation process in ecosystem

4.1. Insights

Insight 1: Although the current scholarship offers increasing evidence that firms change their innovation processes to (i) operate in ecosystems, (ii) engage with different types of ecosystems, (iii) facilitate and govern innovative efforts from complementors, and (iv) create and improve ecosystems, there is a lack of an integrative framework that organizes the variations of innovation processes in ecosystem settings.

By examining the research landscape through topic modeling, bibliometric analysis, and coding, we identified the distribution of words over 16 topics, which provided initial insights into four contingencies that explained variations in innovation processes in ecosystem settings: (i) operating and engaging with different types of ecosystems require variations in innovation processes, (ii) the ecosystem structure, (iii) the challenge of competing by collaborating and coordinating with autonomous firms, and (iv) ecosystem innovation.

First, operating and engaging with a specific type of ecosystem might require variations in innovation processes. Our results indicated that scholars bestowed most of their attention on entrepreneurial ecosystems (topics 3, 7, and 13). Scholars have often adopted economic geography and policy perspectives to examine entrepreneurial activities (including innovation processes) and outcomes (startups, technology) of a given region (Autio et al., 2014, 2018; Spigel and Harrison, 2018). Although less evident in the research landscape, an emergent stream (topic 7) indicates a phenomenon related to firms engaging with entrepreneurial ecosystems, which has major implications for innovation processes. The topics words (e.g., accelerators, entrepreneurs, and ventures) indicate not only the unique components of entrepreneurial ecosystems but that firms engaging with this type of ecosystem face the challenge of creating and managing new structures (e.g., corporate venture capital, acceleration programs, and mentorship programs; a notable example is Decreton et al., 2021). Scholars related to this topic also identified implications for entrepreneurs that decide to engage with a specific ecosystem. Nambisan and Baron (2013, 2021) explain that entrepreneurs might face a dilemma regarding innovation selection, focusing on their own objectives or the ecosystem value proposition. These authors highlight that such a duality of roles can threaten the performance of the venture. We observed similar patterns related to the knowledge ecosystem (topic 8).

Although emergent, this phenomenon of engaging with different ecosystems indicates a relevant contingency for explaining variations in innovation processes: *firms should shape their innovation process according to the type of ecosystem*. Indeed, the analysis of topic words and studies regarding some topics (e.g., 2, 4, 5, 6, 9) reveals that scholars explored the links between firms, ecosystems, and innovation. As an insightful, illustrative example of study, Takey and Carvalho (2016) proposed a theoretical framework of the fuzzy front end to explain that firms should change the way they select and develop innovations by considering the interdependence among ecosystem members and the firm's positioning in the ecosystem. These authors also highlighted that firms should expand their innovation processes to perform activities related to value creation.

The examination of works related to topic 6 provides relevant insights into a second contingency that explains variations in innovation processes: *the ecosystem structure*. For example, in topic 6, some pioneering works (Gawer, 2014; Gawer and Cusumano, 2008) differentiated between innovation activities and objectives according to ecosystem roles: orchestrators (Gawer and Cusumano, 2014) and complementors (Hurni et al., 2021; Soh and Grover, 2020). For example, the role of the orchestrator firms revolves around establishing governance mechanisms (Inoue, 2021; Jingyao et al., 2022), providing tools to sustain the quality of the complementors' innovation efforts (Hilbolling et al., 2021; Huang et al., 2021), and dealing with overall scope and structure of the platform (Cenamor and Frishammar, 2021). Studies related to topic 2 also elucidated that a firm's positioning in the ecosystem has major implications for innovation development and commercialization (Adner and Kapoor, 2010; Garnsey and Leong, 2008). The elements of structure also affect the complementors' innovation. Ganco et al. (2020) found that the position of the actor in the ecosystem (i.e., upstream or downstream) affects the search activity of these firms. Additionally, the current research examines the role that the ecosystem structure plays in the performance of the complementors' innovation (Roma and Vasi, 2019; Soh and Grover, 2022)

Topic	Type	Words	Topic Label	Number of Papers[1]	Topic Proportion (%)	Time Span	Most Cited Papers[2]
Topic 1	Highest Prob	innovation, ecosystem, firms, open, business, knowledge, firm, model, network, smes	Open Innovation Ecosystem: Knowledge Leverage and Absorptive Capacity	42	7,53%	2008:2022	Radziwon and Borges (2019); Chesbrough et al., (2014); Guerrero and Urbano (2017); Holgersson et al., (2018); Wei et al., (2014)
	Frex	open, smes, innovation, capacity, openness, absorptive, exploratory, enterprises, capability, firm					
Topic 2	Highest Prob	firms, technology, firm, ecosystem, standards, technological, innovation, components, standard, patent	Ecosystem and Technology Standards	25	4,91%	2008:2022	Adner andand Kapoor (2010); Gawer and Cusumano (2014); Iyer and Davenport (2008); Tassey (2010); Garnsey et al., (2008)
	Frex	standards, patent, standard, property, intellectual, firms, company, firm, licensing, components					
Topic 3	Highest Prob	policy, entrepreneurial, regional, ecosystem, development, university, economic, universities, academic, role	Entrepreneurial Ecosystem and Knowledge Ecosystem	58	8,73%	2011:2022	Autio et al., (2014); Autio et al., (2018); Acs et al., (2017); Brown and Mason (2017); Guerrero et al., (2016)
	Frex	regional, policy, academic, sciencebusiness, universities, university, science, llc, media, part					
Topic 4	Highest Prob	ecosystem, competition, strategy, evolution, dynamics, servitisation, business, firms, implementation, competitive	Dynamics of Ecosystem: Strategy, Competition, Evolution	32	4,74%	2009:2022	Tiwana et al., (2010); Mack and Mayer (2016); Rohrbeck et al., (2009); Hannah and Eisenhardt (2018); Tiwana (2015); Meijerink and Keegan (2019)
	Frex	competition, servitisation, implementation, evolution, evolutionary, dynamics, built, depth, cooperation, competitive					
Topic 5	Highest Prob	ecosystem, value, actors, entrepreneurial, creation, governance, emergence, systems, evolution, challenges	Value Creation in Ecosystems and Governance Mechanisms	51	8,12%	1993:2022	Moore (1993); Jacobides et al., (2018); Spigel (2017); Adner (2017); Gomes et al., (2018a)
	Frex	emergence, narratives, boundaries, ecosystem, yet, evolution, governance, actors, human, appropriate					

[1] The categorization process was created using the distributed probabilities of topics for each paper. We determined the topic which the paper belonged by analyzing the highest distribution of probability of the paper on the topic. Therefore, despite each paper being composed of all the topics, we extracted the central topic of each paper.
[2] References are mentioned through the order of most citations within the sample.

Topic 6	Highest Prob	platform, platforms, ecosystem, complementors, developers, app, complementary, governance, product, software	Platform Ecosystems	51	7,10%	2008:2022	Gawer (2014); Thomas et al., (2014); Gawer and Cusumano (2008); Parker et al., (2017); Parker et al., (2018)
	Frex	developers, app, platform, complementors, platforms, software, mobile, party, third, users					
Topic 7	Highest Prob	entrepreneurial, ecosystem, entrepreneurs, ventures, venture, social, support, growth, capital, resource	Entrepreneurial Ecosystem Elements: Venture Capital, Accelerators and Entrepreneurs	55	7,56%	2008:2022	Spigel and Harrison (2018); Roundy et al., (2018); Theodoraki et al., (2018); Goswami et al., (2018); Samila and Sorenson (2010)
	Frex	ventures, entrepreneurs, accelerators, venture, rural, accelerator, capital, women, entrepreneurial, community					
Topic 8	Highest Prob	knowledge, ecosystem, innovation, system, high, complexity, actors, complex, government, propose	Innovation and Knowledge Ecosystem	30	5,67%	2013:2022	Alexy et al., (2013); Granstrand and Holgersson (2020); Miller et al., (2016); Nicotra et al., (2018); Russell and Smorodinskaya (2018)
	Frex	complexity, eco, transfer, knowledge, transition, comparative, causal, system, led, high					
Topic 9	Highest Prob	business, ecosystem, models, model, manufacturing, network, companies, value, strategy, management	Business Ecosystem	38	6,79%	2009:2022	Li (2009); Rong et al., (2015); Carayannis et al., (2015); Khavul and Bruton (2013); Graça and Camarinha-Matos (2017)
	Frex	manufacturing, models, business, supply, chain, companies, sustainability, demand, operating, international					
Topic 10	Highest Prob	digital, ecosystem, value, customer, firms, technologies, platforms, transformation, business, engagement	Digital Transformation and Digital Ecosystems	35	5,70%	2013:2022	De Reuver et al., (2018); Gabor and Brooks (2017); Sussan and Acs (2017); Kraus et al., (2019); Elia et al., (2020)
	Frex	digital, customer, transformation, engagement, boundary, digitalisation, user, orientation, media, age					
Topic 11	Highest Prob	innovation, social, development, sustainable, ecosystem, technologies, economic, model, economy, circular	Innovation Ecosystem and Sustainability	42	6,18%	2011:2022	Oh et al., (2016); Sepasgozar et al., (2019); Faucheux and Nicolai (2011); Chuelke-Leech (2018); Brem and Radziwon (2017)
	Frex	circular, disruptive, green, environmental, sustainable, social, economy, several, john, sons					
Topic 12	Highest Prob	startups, ecosystem, innovation, companies, support, market, resources, growth, diversity, network		30	4,99%	2010:2022	

	Frex	startups, diversity, exit, financial, incubators, intermediaries, much, companies, likely, valley	Innovation Ecosystem and Entrepreneurial Ecosystem (Startups)				Clarysse et al., (2014); Nambisan and Baron (2013); De Silva et al., (2018); Walrave et al., (2018); Fukuda (2020)
Topic 13	Highest Prob	entrepreneurship, entrepreneurial, ecosystem, factors, ees, level, economies, elements, support, education	Macro-elements of Entrepreneurial Ecosystem: Education, Economy, Countries	51	7,80%	2015:2022	Audretsch and Belitski (2017); Carayannis et al., (2018); Stam and Van (2021); Bruns et al., (2017); Bischoff (2018)
	Frex	entrepreneurship, ees, education, factors, economies, elements, entrepreneurial, productive, group, european					
Topic 14	Highest Prob	industry, technology, capabilities, market, technologies, value, entry, innovation, complementary, technological	Ecosystem and Industry Transitions	31	5,04%	2007:2022	Teece (2007); Helfat and Raubitchek (2018); Adner and Kapoor (2016); Ansari et al., (2016); Carvalho (2015)
	Frex	entry, entrants, leaders, industry, copyright, assets, capabilities, dominance, mnes, industries					
Topic 15	Highest Prob	ecosystem, service, innovation, partners, sustainable, value, collective, opportunities, activities, three	Ecosystem Value Co-creation: Activities, Uncertainty, Collaboration	32	5,25%	2006:2022	Adner (2006); Davis (2016); Overholm (2015); Gomes et al., (2018b); Kahle et al., (2020)
	Frex	collective, service, partners, uncertainties, sharing, project, collaborative, sustainable, managing, opportunities					
Topic 16	Highest Prob	knowledge, social, smart, city, local, cities, government, information, communities, urban	Smart Cities and Digitalization	24	3,87%	2016:2022	Benitez et al., (2020); Ardito et al., (2019); Gagliardi et al., (2017); Huang, et al., (2017); Visnjic et al., (2016)
	Frex	city, cities, smart, urban, trust, communities, tech, citizens, local, commerce					

Table 2. Topic Modeling

Confronting challenges associated with collaboration, coordination, and governance proposed by scholars related to topic 6 with works related to open innovation (topic 1) (Chesbrough et al., 2014; Radziwon and Borges, 2019), we found why these activities assume unique nuances in ecosystems. We associated these nuances with the contingency "*the challenge of competing by collaborating and coordinating with autonomous firms.*" Value creation is not confined to obtaining external knowledge to develop standalone products (as examined by open innovation scholars), rather it involves external actors to generate a superior set of interdependent offerings to clients in relation to rival ecosystems (Adner, 2006; Adner and Kapoor, 2010; Cennamo and Santaló, 2019; Gawer and Cusumano, 2014). Because a single firm might not fulfill an ecosystem's value proposition, firms must deploy new capabilities to collaborate with a new type of partner: the complementors (Cennamo and Santaló, 2013, 2019; Shipilov and Gawer, 2020). Given that it is not possible to rely on contracts to manage these autonomous complementors, firms should deploy unique governance structures to coordinate with them (Jacobides et al., 2018) and to develop and commercialize the right set of interdependent offerings to clients (Rietveld et al., 2020). Thus, some recent works have documented that companies cope with the challenge of deploying the right mechanisms to stimulate the complementors to innovate and remain in the ecosystem (Kretschmer et al., 2022). For example, Sun and Zhang (2021) identified that firms built specific knowledge to facilitate the development, while Rietveld et al. (2020) proposed a mechanism related to providing high-quality information regarding the end customers' need to complementors, thus facilitating the understanding of the market trends.

The analysis of topics indicates that firms also develop and improve their ecosystems. For example, studies related to topics 2 and 5 showed that firms should create an ecosystem to fulfill a platform or a systemic innovation (Adner and Kapoor, 2010; Gawer and Cusumano, 2014). Indeed, the topic words suggest that the construct platform (a technological artifact; Gawer and Cusumano, 2014) differs from the ecosystem. Thus, developing a platform is not enough to generate an ecosystem. An ecosystem does not simply emerge and requires the purposefully designing of activities (Jacobides et al., 2018). Additionally, some studies have shown how firms modify their business model to move from standalone products to an integrated ecosystem value proposition (Stonig et al., 2022). This research stream indicates the need to modify the product and the activities to allow the contribution from complementors (Kolagar et al., 2022; Stonig et al., 2022) and the need to develop new relational and technological capabilities to address the ecosystem (Schreieck et al., 2021). Further, studies from topics 2 and 4 revealed that firms might change the ecosystem structure to address bottlenecks and competition in ecosystems (Adner and Kapor, 2010; Hannah and Einsehardt, 2018). Technological change necessitates constant renewal and transformation of the ecosystem (Breslin et al., 2021). For example, complementors could become standardized or stop contributing to the ecosystem value proposition, which requires renewing the structure of relationships, and, in some scenarios, attracting new complementors (Holgersson et al., 2022). Overall, these elements highlight a fundamental feature of the ecosystem; they are created, transformed, and evolve over time (Thomas et al., 2022).

Although analysis of the research landscape provides initial clues on variations in innovation processes in ecosystem settings, showing a multilevel, multi-faceted phenomenon, our results indicate that a more integrative understanding of how variations in innovation processes occur owing to some contingencies is lacking. In this vein, Figure 6 (topic correlation network) provides complementary evidence. Although this figure illustrates a rich network with a different, diverse set of topics, our analysis indicates that there are few connections (correlations) among the topics. The results show the correlation between the entrepreneurial ecosystem and the knowledge ecosystem (topics 3 and 13/topics 7 and 12). This indicates that some papers provide the initial basis for understanding how different ecosystems are connected; however, the landscape shows that additional efforts are needed to integrate this dispersed literature. This result might suggest that scholars have focused on discovering the different pieces of a complex puzzle rather than understanding the connection among them.

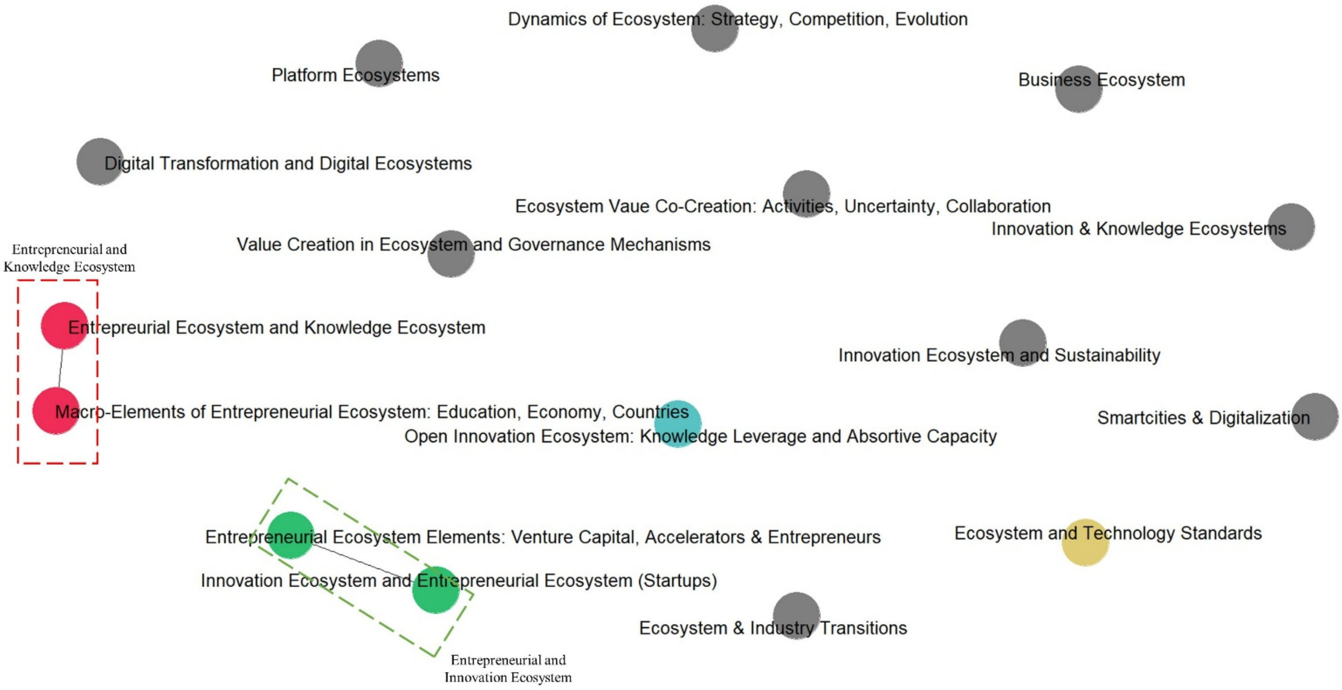

Figure 6. Topic Correlation Network

Although innovation represents a central concept that connects different types of ecosystems, our analysis of the keyword network (Figure 7) indicates that the current literature offers a limited systemic characterization of innovation processes in ecosystems, considering their multilevel, multi-aspect nature, mechanisms, and dynamics. This absence of an integrative framework leads to the risk of duplication of efforts and increases the difficulties of knowledge growth.

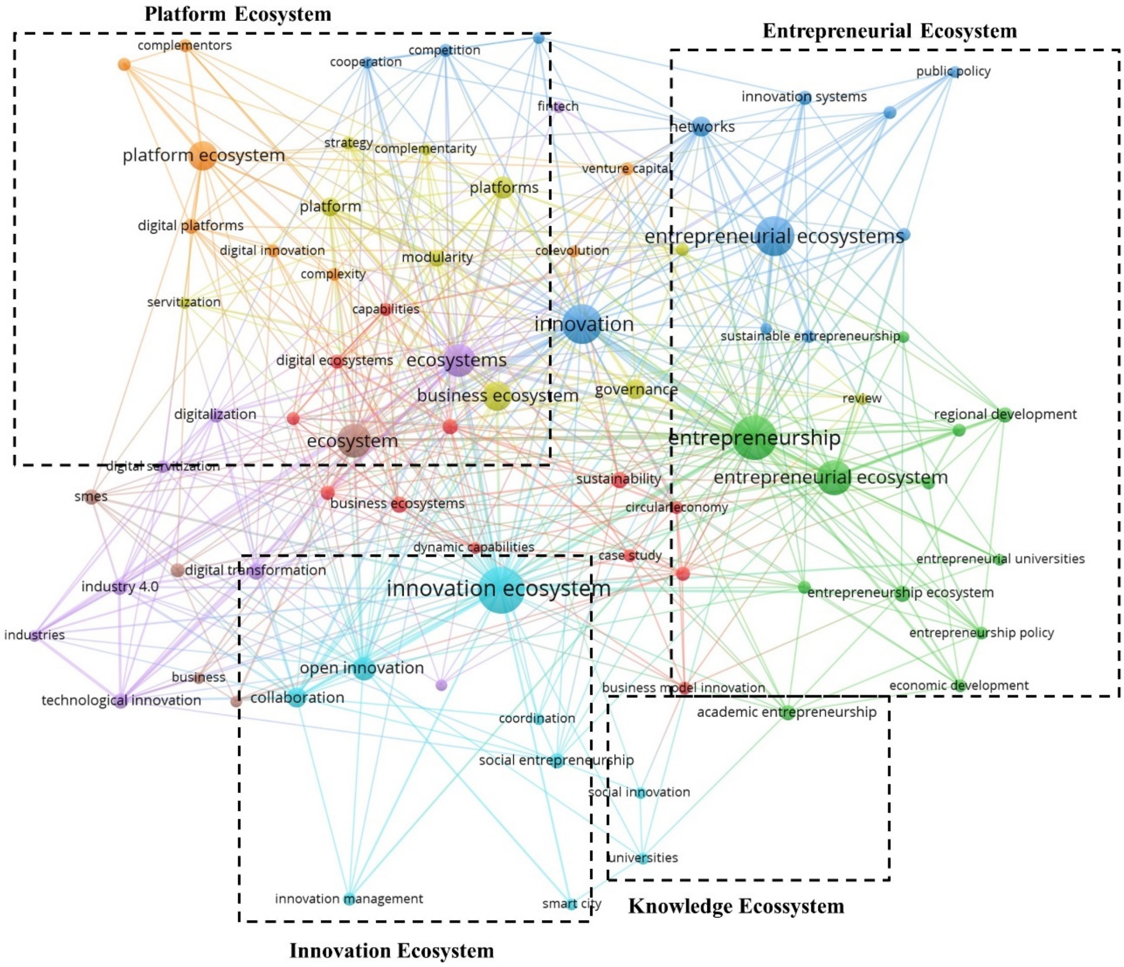

Figure 7. Keyword Network

Insight 2: To operate in an ecosystem and engage with different types of ecosystems, firms build ecosystem-based innovation processes.

After reviewing the research on ecosystem and innovation processes, we propose a new category of innovation processes in ecosystem settings. We label it ecosystem-based innovation process to describe situations in which a firm (e.g., an ecosystem leader, a complementor) adapts or builds innovation processes according to a given ecosystem structure and the type of ecosystem (Figure 5). Ecosystem-based innovation processes refer to a firm's journey in adjusting its innovation processes to operate in a given ecosystem. As mentioned earlier, the ecosystem structure (i.e., roles and positions) is a crucial contingency that explains variations in innovation processes. A growing stream of research (Adner, 2017; Adner and Kapoor, 2010; Ganco et al., 2020; Gawer, 2021; Gomes et al., 2022; Kapoor, 2018; Rong et al., 2018 Shilplov and Gawer, 2020) suggests that the configurational features (e.g., roles, position, flows, links, and value propositions) might require that firms (ecosystem leaders and complementors) set unique innovation processes.

By framing innovation processes as a combination of components to generate novelties, Ganco et al. (2020, p. 1) examined the “effect of the ecosystem-level structure on the innovative processes for upstream and downstream firms in an ecosystem.” Ganco et al. (2020, p. 3) also proposed that “the more downstream the firm is located, the more opportunities for novel combinations it has for mixing and matching components produced by upstream firms.” This requires developing an “innovative search that combines a variety of upstream components while such combinatorial search processes may not be available to upstream firms” (Ganco et al., 2020, p. 3). Ganco et al. (2020, p. 3) also explained that upstream and downstream firms might adopt different search criteria. While upstream firms might focus their search on “how the components they produce perform,” downstream firms face the challenge of considering “the performance contribution of components that are produced upstream, and that are integrated by them.” Moreover, altering the flow of inputs and outputs in the ecosystem from sequential (A > B > C) to a pooled one (A + B > C) or *vice-versa* modifies the innovative search. Empirically, Adner and Kapoor (2010) also identified that innovation challenges (development and need for information) faced by downstream firms differ from those of upstream ones. Thus, the firm should recognize its position in the structure of interdependence (Burford et al., 2021; Hsuan et al., 2021) by understanding who does what in the ecosystem (Gomes et al., 2021) and how value is being shared among ecosystem members (Adner, 2017). Consequently, firms might adapt their processes for search and selection from firm-centered to ecosystem-centered (Randhawa et al., 2021). However, Hannah and Eisenhardt (2018) explained that firms change their innovation capabilities when they assume the role of other firms in the ecosystem.

While Ganco et al. (2020) examined how the position in the ecosystem shapes innovation processes, a correlated research stream (Foerderer et al., 2018; Gawer and Cusumano, 2014; Gawer, 2014; Lee and Hwang, 2018; Shipilov and Gawer, 2020) highlighted that ecosystem-based innovation processes might assume unique features depending on the firm’s role of an orchestrator or complementor in the ecosystem. Generally, studies in our sample indicated that orchestrators and complementors should build a collective understanding of the ecosystem value proposition, making sense of which part of such value proposition is their responsibility, which shapes idea generation and innovation selection processes (Cenamor, 2021). For example, the orchestrator defines the systemic innovation, such as functionalities (Cennamo and Santaló, 2019; Dattée et al., 2018), and indicates what complementary innovations should be undertaken by the focal firm and the complementors (Gomes et al., 2022; Murthy and Madhok, 2021).

Complementors, in turn, might organize the idea generation to make sense of the ecosystem value proposition and identify which initiatives (e.g., products and services) would complement such efforts from the focal firm and other complementors (Linde et al., 2021; Oskam et al., 2021; Thomas and Ritala, 2022). Additionally, the complementors might search for innovations that "highlight novel technological opportunities" for systemic innovation, which "will attract the attention of a large number of early adopters" (Cenamor, 2021, p. 340). Further, Moore (2006) explained that complementors should focus their search for ideas on a particular market niche in the ecosystem.

We also identified differences regarding innovation selection. An orchestrator might organize their innovation selection to address correlated challenges, such as technical features of the product/platform and offerings (applications in the case of digital platforms; Foerderer et al., 2018; Jacobides et al., 2018; Ozalpet al., 2018; Shipilov and Gawer, 2020). Cennamo and Frishmmar (2021) explained that orchestrators provided both systemic innovations (e.g., platform) and some complementary innovations. Complementors might evaluate innovations if their ideas attend to a particular or diverse market niche in a specific ecosystem or multiple ones (Tavalaei and Cennamo, 2021). Examining digital platforms, Hurni et al. (2021, p. 2) explained that complementors determine "by themselves what kind of software they will develop" (e.g., a game, productivity app, or health app) and "how much effort they invest into development." Such autonomy is also present in the development process (Hurni et al., 2021; Wu et al., 2022). For example, Hurni et al. (2021) mentioned that complementors decided "what features their innovation should have" (e.g., quality level). However, Ozalp et al. (2018) indicated that complementors should consider how technological governance (defined by orchestrators) shapes complementors' development efforts.

Indeed, orchestrators make a fundamental decision regarding the modularization of systemic innovation (Tee, 2019). Modularization refers to the degree that the production of innovations might be separated into different, interdependent modules which perform a specific set of functions (Jacobides et al., 2018). Modularization is central to unleashing a fundamental feature of ecosystems—interdependence (Shipilov and Gawer, 2020). Considering the interdependencies between complementors and orchestrators, scholars (Jacobides et al., 2018; Ozalp et al., 2018) have remarked that orchestrators should consider how their development decisions might affect the complementors' innovation efforts. For example, by examining the videogame industry, Ozalp et al. (2018) demonstrated that the addition of new, radical features in a new console generation (performed by the orchestrator) increased partners' defection, entry timing (related to innovation selection decisions) and time taken for new game development.

Our analysis identified that such differences between complementors and orchestrators also involve innovation diffusion (Wang and Miller, 2020). For example, complementors should define whether they would diffuse their products in a particular ecosystem or across multiple ones (Rietveld and Eggers, 2018; Selanderet al., 2013; Soh and Grover, 2020; Tavalaei and Cennamo, 2021), while orchestrators should develop policies for pricing promotion and diffusion of their offerings and complementors' innovations (Gomes et al., 2022; Rietveld et al., 2020; Schreieck et al., 2021). Gomes et al. (2022) explained that orchestrators might build unique sales processes to promote systemic innovation and their complementary offerings.

Our analysis captured that firms alter their innovation processes to engage with the entrepreneurial ecosystem and knowledge ecosystem. Decreton et al. (2021, p. 112) explained that engagement with the entrepreneurial ecosystem shapes idea generation as "outposts in vibrant entrepreneurial ecosystems represent great opportunities for companies to detect upcoming disruptions and discover ground-breaking technologies and new business models." Therefore, firms should build unique structures and processes (e.g., acceleration programs) to engage with startups related to a particular entrepreneurial ecosystem (Decreton et al., 2021). Recent research has shown how venture capital (Breznitzet al., 2018; Van Angeren and Karunakaran, 2022) and acceleration/incubation programs (Lamine et al., 2018) are beneficial to the development of complementary offers. Additionally, firms are creating structures for engaging with universities. Audretsh and Link (2019, p. 430) discussed the notion of research joint ventures as "multiple units, including for-profit firms but also non-profit research institutions and universities, bounded by a formal or informal agreement to cooperate with the goal of facilitating research and ultimately enhancing firm performance and profitability." Interestingly, the authors argue that a research jointure venture can help in reducing the high risk and uncertainty associated with certain activities carried out by individual firms (Audretsch and Link, 2019). Moreover, Gomes al et al. (2022) explained that firms build and manage such structures (mentorship programs, technology transfer activities) to perform co-development efforts with startups and scientists. The engagement with startups and scientists is also facilitated by mechanisms built by the knowledge ecosystem. For example, technology transfer offices are fundamental to "help lower barriers to value creation and to accelerate productive entrepreneurship activities in the territories in which they operate" (O'Kane et al., 2021, p.

1837). Together, this new evidence highlights the need to modify and create innovation processes to engage with different types of ecosystems.

Insight 3: To compete with other ecosystems and provide a superior value proposition through the autonomous yet orchestrated contribution of complementors, firms build innovation processes within the ecosystem.

Our review revealed a new level for innovation processes: the ecosystem level. We labeled it "innovation processes within the ecosystem" to represent situations in which collective innovation activities among ecosystem partners are performed to deliver value to clients and help to compete against rival ecosystems (Figure 5). The locus of innovation activities is outside the organizational boundaries (Altman et al., 2022) and refers to a response to the contingency "the challenge of competing by collaborating and coordinating with autonomous firms" (Insight 1). In line with Garud et al. (2013), innovation processes within the ecosystem correspond to situations in which a firm interacts with a constellation of ecosystem members (e.g. complementors, clients) to innovate. Cooperating with autonomous actors implies that focal firms can shape but cannot manage the innovation processes of ecosystem partners (Gomes et al., 2022); however, focal firms can provide unique mechanisms to facilitate and trigger the partners' interactions to innovate.

Unlike the ecosystem-based innovation processes, which refers to how the role and position of a firm in a given ecosystem shape the innovation processes, innovation processes within the ecosystem focus on the pooling of resources and activities concerning innovation processes within the community and the overall innovation output in relation to rival ecosystems (Van Angeren and Karunkaran, 2022; Zapadka et al., 2022). Thus, the innovation processes within the ecosystem might capture the overall ecosystem capability of generating new ideas and transforming them into innovations (Gomes et al., 2022, 2021; Overholm, 2015). Although this type of innovation process goes beyond the reach of any individual firm, focal firms have a central role in organizing and improving the collective efforts to build a collective infrastructure and obtain the right outputs to compete against rival ecosystems (Gomes et al., 2021). Schreieck et al. (2021, p. 3) demonstrated that SAP's journey toward a successful platform began with "the ability to enable the development and deployment of modular, cloud-based third-party applications."

We identified that orchestrators operate to unleash value creation within the ecosystem (e.g., sharing opportunities with partners; Gomes et al., 2022; Murthy and Madhok, 2021; Overholm, 2015), boost complementor's creativity (Parker et al., 2017), and facilitate the development of innovations from complementors, including radical ones (e.g., providing development toolkits; Inoue, 2021; Ozalp et al., 2018). Indeed, such innovation processes within the ecosystem are crucial to enable two distinctive features of innovation in ecosystems: generativity and complementarity. Consistent with the literature, generativity corresponds to “the capacity to produce unprompted change driven by large, varied, and uncoordinated audiences” (Zittrain, 2006, p. 1980), while complementarity refers to situations in which the value created by two or more organizations is higher than what they could create individually (Jacobides et al., 2018; Gomes et al., 2021). Both features are not automatic and require purposeful actions (Gomes et al., 2021).

To do so, we identified in our sample that firms add new activities to their innovation processes related to creating collective events and structures to share the ecosystem vision and identify and value proposition with ecosystem members (Linde et al., 2021; Malherbe and Tellier, 2022; Schreieck et al., 2021). Such activities might be crucial for shaping the way less coordinated partners search for new ideas (Oskam et al., 2021). For example, Foerderer (2020) found that Apple’s events for developers contributed to increasing the complementors’ innovation performance. Firms might also create new structures to collectively scan and recognize new opportunities among ecosystem members (i.e., new markets and new technologies; Gomes et al., 2022). Firms also signal opportunities for complementors to materialize value creation (Hukal et al., 2020). For example, ecosystem leaders might change the value proposition scope by creating product categories (Cennamo and Santaló, 2019), which increases the incentives for innovation in the ecosystem (Boudreau, 2012) by signalizing gaps in the current ecosystem value proposition (Gomes et al., 2022).

Studies have also provided initial insight into the nature of value propositions and how ecosystem members generate ideas. Malherbe and Tellier (2022) explained that a loose proposition with a high degree of freedom might lead ecosystem partners to define their space of exploration and identification of opportunities with greater autonomy (Malherbe and Tellier, 2022). In contrast, an ambitious, well-detailed value proposition might involve defining a priori which opportunities and ideas should be performed by ecosystem partners (Malherbe and Tellier, 2022).

Orchestrators also deploy unique mechanisms to shape innovation selection (Hurni et al., 2021; Iyer and Davenport, 2008; Sun and Zhang, 2021) and facilitate development efforts within complementors to compete against rival ecosystems (Gomes et al., 2022; Huang et al., 2018; Hukal et al., 2020; Masucci et al., 2020; Rong et al., 2015). For example, by using events to increase awareness regarding the ecosystem value proposition, orchestrators indicate expected innovations from complementors (Oskan et al., 2021) or innovation selection criteria (Gomes et al., 2022). Orchestrators can also use incentives and awards to induce the complementors' innovation selection (Foerderer et al., 2021). Additionally, firms can also operate to improve development efforts to guarantee high-quality innovations from complementors (Cennamo and Santaló, 2019; Cennamo et al., 2020; Hodapp and Hanelt, 2022; Jingyao et al., 2022; Jones et al., 2021; Karagiannis et al., 2022; Kretschmer et al., 2022; Riquelme-Medina et al., 2022). For example, firms might facilitate knowledge exchange and collaborative development structures for ecosystem partners (Gomes et al., 2022, Ritala et al., 2009). In this vein, a fundamental mechanism is the use of boundary resources (Fink et al., 2020) by "existing ecosystem partners and new third-party providers, and by ensuring a sufficient level of quality through control mechanisms supported value co-creation in the ecosystem because it leads to high-quality applications" (Schreieck et al., 2021, p. 377). Boundary resources can be viewed as "artefacts plastic enough to cut across multiple social worlds by providing enough structure to support several parties and their employed activities within separate social worlds" (Ghazawneh and Henfridsson, 2010, p. 4), such as technological toolkits (Ozalp et al., 2018). Orchestrators also face the ongoing challenge of adapting the technological governance and boundary resources to address opportunities and threats (Rietveld et al., 2020; Schreieck et al., 2021), which requires the orchestrators to carefully assess how changes would impact the complementor's development efforts (Ozalp et al., 2018).

A unique activity related to innovation processes within the ecosystem corresponds to the quality assessment of the contribution of complementors (Hilbolling et al., 2021; Huang et al., 2021; Kolagar et al., 2022; Leten et al., 2013; Moon and Lee, 2020). The objective is to "exclude access to low-quality complementors, providing a subsidy to high-quality complementors, and developing high-quality first-party" offerings (Huang et al., 2021, p. 4432). These quality standards, although less defined in relation to traditional suppliers (Jacobides et al., 2018), orient the complementor's development efforts (Huang et al., 2021).

Our analysis also indicated some variations in innovation diffusion within the ecosystem. For example, the orchestrators might build and share an integrated ecosystem value proposition with a pool of offerings for clients (Stonig et al., 2022) instead of fragmented or a single firm's value proposition and offerings (Trischler et al., 2020). Indeed, orchestrators focus on the general ecosystem output by combining their sales channels with complementors to deliver more value to clients in comparison with rival ecosystems (Fang et al., 2021; Gomes et al., 2022; Nambisan and Baron, 2021). Moreover, a critical aspect concerning innovation diffusion within an ecosystem consists of value distribution, which shapes the alignment of ecosystem members and their bargaining power and capacity to respond to rival ecosystems (Malherbe and Tellier, 2022).

Insight 4: Firms establish new processes to create, improve, and transform their ecosystem structure.

Thus far, we have discussed the literature pertaining to innovation processes in a given ecosystem structure (i.e., the ecosystem-based innovation processes and innovation processes within the ecosystem). However, our results identified a new type of innovation, that is, ecosystem innovation. Ecosystem innovation refers to the process of creating new or modifying existing ecosystem structures (in line with Kolagar et al., 2022; Stonig et al., 2022; Thomas et al., 2022). For example, moving toward an ecosystem of offerings requires purposeful actions such as designing the ecosystem value proposition, flows, activities, links, and roles (e.g., Stonig et al., 2022). Additionally, the studies in our sample also indicate that ecosystems and ecosystem competition are constantly changing (e.g., Gomes et al., 2022); therefore, firms employ unique mechanisms to identify and modify the ecosystem structure (e.g., Holgersson et al., 2002; Kolagar et al., 2022). The creation and modification of ecosystems refer to a unique variation of innovation processes: the ecosystem structure innovation processes (Figure 3). The ecosystem structure innovation process refers to situations by which firms create new or modify the ecosystem structure (e.g., value proposition, roles, activities, links, and flows).

A growing research stream has documented a new type of innovation; that is, ecosystem innovation, in which firms create a new ecosystem (Dattée et al., 2018) and improve (e.g., enhancing value propositions, roles, or flows; Gomes et al., 2022; Sahasranamam and Soundararajan, 2022), expand (increase the number of actors; Kolagar et al., 2022; Oghazi et al., 2022), contract (e.g., remove roles; Holgersson et al., 2022), or transform an existing ecosystem (e.g., radically changing connections or value propositions; Breslin et al., 2021). The turning point for considering that firms might perform this type of innovation was the notion of the ecosystem as a structure (Adner, 2017), and different design choices regarding modularization might lead to different ecosystem configurations (Jacobides et al., 2018; Tee, 2019). Breslin et al. (2021, p. 65) explained that "ecosystems are created, shaped, and maintained through innovation." Indeed, innovation is crucial to energize "the foundational rules of interaction" and, in some cases, to radically transform by "disrupting existing connections and relations" (Breslin et al., 2021, p. 65).

Our analysis identified some unique activities of innovation processes focused on ecosystem innovation: ecosystem structure innovation processes. Concerning idea generation, firms might scan for value propositions that require the creation of a new ecosystem (Dattée et al., 2018; Stonig et al., 2022) or examine situations in which the ecosystem requires changes (Gomes et al., 2022) owing to competitive pressures or technological changes (Sahasranamam and Soundararajan, 2022). Kolagar et al. (2022) indicated that firms might assess the ecosystem's health and performance by analyzing when it is necessary to change roles, governance, and agreements. Studies have also provided some insights into ecosystem innovation selection. For example, Oskam et al. (2021) focused on how focal firms select the ecosystem value proposition. Jacobides (2022) indicated that firms should evaluate the cost and complexity of an ecosystem idea. Dattée et al. (2018, p. 26) proposed that firms should consider "where to steer the development of 'their' ecosystem […] for eventual value capture and to identify unwanted developments" of the ecosystem.

Ecosystem development entails activities related to defining the ecosystem value proposition and goals (Randhawa et al., 2021; Oskam et al., 2021), technological and economic governance (Shipilov and Gawer, 2020), defining roles, activities, flows, and links (Ganco et al., 2020; Gomes et al., 2021; Kapoor, 2018), mapping actors (Takey and Carvalho, 2016), and nurturing processes in which focal firms incubate strategic complementors, identify leader partners, and integrate such partners in the ecosystem (Rong et al., 2015). A growing research stream indicates that the degree of openness is a critical activity which shapes the ecosystem structure as well as other innovation processes in ecosystems (Inoue, 2021; Jacobides et al., 2018; Roma and Vasi, 2019). Openness refers to the degree by which a specific ecosystem might receive specific innovations from complementors in terms of ecosystem membership rules or systemic innovation design (Benlian et al., 2015; Inoue, 2021; Parker and Van Alstyne, 2018) or which modules can be developed by complementors (Gomes et al., 2022). Scholars remarked that the degree of openness might affect the ecosystem structure (Tee, 2019) and, subsequently, the design choices. For example, Inoue (2021, p. 3–4) explained that "excessive openness may lead to a loss of profits due to the increase in low-quality complementary innovations from complementors." Consequently, the openness might affect ecosystem development in terms of capacity for new complementors (Zaggl et al., 2020). Cenamor and Frishammar (2021) bridged modularization (a critical activity performed during ecosystem-based innovation processes) and openness (performed in the innovation processes within the ecosystem) by deciding the type and number of modules focal firms would allow complementors to enter and contribute to.

Such collection of activities might lead to distinct, unique features of the ecosystem (Inoue, 2021) in relation to rival ones in terms of ecosystem value proposition, identity, the set of interdependent offerings, incentives for complementors, innovation capacity, boundary resources, quality of links, and bottlenecks (Gomes et al., 2021, 2022; Stonig et al., 2022; Teece, 2018). However, ecosystem innovation is not confined to orchestrators. Our analysis also identified that the participation of complementors might go beyond providing complementary innovations in terms of products and services to influencing the ecosystem structure. For example, Hilbolling et al. (2019) investigated the role of complementors in the Philips ecosystem as connectors by bridging this ecosystem with others.

Ecosystem diffusion also brings unique challenges. For example, clients might recognize the existence and legitimacy of an ecosystem and its independent offerings (Press et al., 2020; Thomas and Ritala, 2022; Walrave et al., 2018). Thomas et al. (2022, p. 9) explained ecosystem diffusion as “legitimate, accepted collectively in the wider societal and competitive context.” Moreover, the diffusion of an ecosystem is not confined to clients, but it involves the complementors (Dattée et al., 2018), including potential ones (Thomas and Ritala, 2022).

Insight 5: The complex, dynamic interplay across ecosystem-based innovation processes, innovation processes within the ecosystem, and ecosystem structure innovation processes involve evolutionary and temporal complexities. To cope with such complexities, managers use innovation process regulation.

Prior insights revealed the variations in innovation processes in ecosystem settings. However, our results also unfold the interplay across ecosystem-based innovation processes, innovation processes within the ecosystem, and ecosystem structure innovation processes, which entails a complex, dynamic nature characterized by evolutionary (co-evolution) and temporal complexities.

This interplay entails the co-evolution of multiple aspects across different organizations and levels (Adner, 2017; Gomes et al., 2022, 2021; Luo, 2018; Thomas and Autio, 2020). These aspects include a firm’s innovation processes (ecosystem-based innovation processes) concerning its roles and position in a given competitive ecosystem, innovation processes within the ecosystem, ecosystem structure innovation processes, and technological and market conditions. For example, the evolving nature of systemic innovation modularity (Jacobides et al., 2018) might affect ecosystem structure and innovation processes within the ecosystem (as modularization might require new roles in the ecosystem structure and the interaction among incumbent and new ecosystem members). Additionally, the choices of the ecosystem value proposition (ecosystem structure innovation processes) might impact the depth and breadth of the innovation processes within the ecosystem over time. Moreover, these aspects might co-evolve based on opposite, contradictory forces, such as competition and stability versus flexibility. For example, while some ecosystem members might focus on stability (sustaining their ecosystem-based innovation processes, roles, and activities), others might search for disruption (Ozalp et al., 2018), which might reshape the ecosystem value proposition and structure (Kapoor and Furr, 2015), ecosystem-based innovation processes, and innovation processes within the ecosystem (Ganco et al., 2020). Some actors might focus on taking the roles of partners, which might require modifying their innovation activities (ecosystem-based innovation processes) in a given ecosystem (Hannah and Eisenhardt, 2018).

Further, the ecosystem structure evolves through different stages with unique challenges in the form of discovering the value proposition and establishing the governance and ecosystem resourcing mechanisms (Thomas et al., 2022). This, in turn, might affect the ecosystem-based and innovation processes within the ecosystem. For example, at the beginning of an ecosystem, the ecosystem value proposition might be uncertain, and the capacity of orchestrators to attract and shape complementors' innovation processes might be limited (Dattée et al., 2018). Consequently, the innovation processes within the ecosystem might be constrained, requiring the orchestrators to organize their ecosystem-based innovation processes to address different roles and aspects of the ecosystem value proposition. Moreover, the prominence of orchestrators in ecosystem-based innovation processes might vary according to the entry of new complementors over time (Thomas and Ritala, 2022). Finally, unforeseeable competition pressures against rival ecosystems and technological changes (Kapoor and Argawal, 2017; Ozalp et al., 2018) might require substantial innovations in the ecosystem structure (Gomes et al., 2022), which might also demand the alteration of the boundaries of ecosystem-based innovation processes and innovation processes within the ecosystem over time.

The interplay between the variations in innovation processes in the ecosystem is also characterized by multiple distinct temporal rhythms. For example, firms located upstream might find it challenging to align multiple partners (till the end customer) with distinct innovation capacities and innovation speeds, which might involve different rhythms and time frames (Adner, 2006, 2017; Adner and Kapoor, 2010). Temporal discrepancies might also occur when actors decide to alter systemic innovation (e.g., platform) in terms of scope, which demands implementing changes in the ecosystem structure, attracting the right complementors, and obtaining high-quality complementary innovations—each activity with a specific time frame (Gawer and Cusumano, 2014; Gomes et al., 2022). Bottlenecks in technological components might constrain ecosystem evolution, which might require adaptations in firms' innovation processes and ecosystem structure (Hannah and Eisenhardt, 2018; Masucci et al., 2020), leading to different rhythms. Moreover, firms changing from standalone products to an ecosystem of interdependent offerings (Stonig et al., 2022) might face challenges in synchronizing the ecosystem-based innovation processes, innovation processes within the ecosystem, and ecosystem structure innovation processes.

Our analysis coded how managers can address these complexities through "*innovation process regulation.*" Building on the regulation approach, which might involve dealing dynamically with competing goals in ecosystem settings (Dattée et al., 2018; Gomes et al., 2022; Griffin and Grote, 2020; Thomas et al., 2022), we used the term "*innovation process regulation*" to describe situations in which managers strategically increase or decrease the boundaries and resource allocation concerning ecosystem-based innovation processes, innovation processes within the ecosystem, and ecosystem structure innovation processes to address evolutionary and temporal complexities (Figure 5). We identified some actionable constructs concerning "*innovation processes orchestration*" in the form of "*managing ecosystem value proposition*" and "*controlling modularization/openness*" to moderate the interplay across ecosystem-based innovation processes, innovation processes within the ecosystem, and ecosystem structure innovation processes. For example, to reduce complexity at the initial stages of an ecosystem, some firms might design a loose value proposition (Malherbe and Tellier, 2022), which tends to require the development of a simpler ecosystem structure and the attraction of a limited number of complementors (Dattée et al., 2018) to address critical activities of the innovation processes within the ecosystem. However, in such a situation, firms might tend to increase the boundaries and resource allocation to ecosystem-based innovation processes rather than innovation processes within the ecosystem.

Firms might also strategically set different degrees of systemic innovation modularization and ecosystem openness (Alam., et al., 2022; Hodapp and Hanelt, 2022; Jacobides et al., 2018; Parker and Van Alstyne, 2018; Stonig et al., 2022; Tee, 2019) with substantial implications for innovation processes in ecosystems. For example, the definition of modularization for ecosystem-based innovation processes might affect the need for innovation processes within the ecosystem (many modules might be addressed by complementors) and ecosystem structure innovation processes (different modules might require unique roles in the ecosystem structure).

Additionally, a scenario based on a more restricted degree of ecosystem openness might lead a firm to redesign the boundaries of its ecosystem-based innovation processes to assume the roles of distinct ecosystem actors.

If the firms need to boost generativity and complementarity, managers might face growing evolutionary complexity. By employing innovation process regulation, managers might augment the degree of openness, investing in increasing the boundaries of innovation processes within the ecosystem to drive ecosystem members' innovation processes and outcomes. Finally, to address technological generation transitions (Ozalp et al., 2018), managers can use innovation process regulation to address both evolutionary complexity and temporal complexity. For example, a new systemic innovation generation might also involve innovation in the ecosystem structure (Gomes et al., 2022), requiring substantial learning and new knowledge acquisition from complementors, which might affect the capacity of complementors to generate new offerings initially (Ozalp et al., 2018). Orchestrators might augment the boundaries of ecosystem-based innovation processes to also develop critical complementary innovations with the new technological features of the platform. Progressively, orchestrators can invest more in innovation processes within the ecosystem by disseminating technological toolkits (Shipilov and Gawer, 2020) and building structures (hubs and acceleration programs; Gomes et al., 2022) to facilitate platform adoption and complementors' development efforts. Moreover, firms might use innovation process regulation to change the boundaries and resource allocation for ecosystem-based innovation processes and innovation processes within the ecosystem to engage with the entrepreneurial and knowledge ecosystem (Gomes et al., 2022).

5 THEORY AND HYPOTHESIS FOR STRUCTURAL MODEL

The insights provided by the systematic literature review allowed us to build an initial bridge between innovation processes in ecosystem settings by investigating the contingencies that explain the variations of innovation processes in ecosystem settings. In this sense, the review's findings have uncovered three unique innovation processes that occur in ecosystem settings. First, firms build ecosystem-based innovation processes to deal with the ecosystem structure and to engage with different types of ecosystems (e.g., Decreton et al., 2021; Ganco et al., 2020). Second, in ecosystem settings, there are unique processes in which a constellation of firms engages to create a systemic innovation and compete against rival ecosystems labeled innovation processes within the ecosystem (e.g., Fink et al., 2020; Zapadka et al., 2020). Lastly, firms build unique processes to create and innovate the ecosystem structure via ecosystem structure innovation processes (e.g., Kolagar et al., 2022; Stonig et al., 2022).

Additionally, our findings show that to deal with the complexity of innovation processes in ecosystem settings (Garud et al., 2013) and manage the resources and boundaries regarding the different types of innovation processes, firms strategically address these processes by using mechanisms such as increasing and decreasing openness to allow the participation of more actor or addressing competition by modifying the value proposition. Despite being insightful, our integration of the current literature via the systematic literature review has uncovered a few gaps that still need to be addressed.

First, while we capture how new contingencies have affected the development of new innovation processes, few studies have addressed how these new contingencies affect the emergence of different innovation processes. A notable exception is Ganco et al. (2020) who built a model to investigate how the ecosystem structure affected the search process of firms. The authors' findings have provided the ecosystem literature with key insights to understand how ecosystem structure changes the innovation processes of firms operating in ecosystem settings. What remains is to understand how the development of new innovation processes is affected by ecosystem contingencies, such as the strategy of the firm operating in the ecosystem.

Second, a significant stream of research on the ecosystem and innovation processes literature is the idea of ecosystem strategy (e.g., Gomes et al., 2023; Rietveld et al., 2019; Hannah and Eisenhardt, 2018). A myriad of authors has sought to explain how ecosystem leaders build legitimacy in the ecosystem (Thomas and Ritala, 2022), how they attract new partners, how they transform the ecosystem, and how they remain competitive over the development of the ecosystem (Linde et al., 2022; Stonig et al., 2022). Additionally, researchers have also called for a deep understanding of how complementors make decision in ecosystem settings (e.g., Cenamor, 2021). For example, recent research is exploring how complementors make strategic decisions regarding where to diffuse their innovation and other decisions regarding multihoming (e.g., Rietveld and Eggers, 2018), and, interestingly, how complementors are fundamental in expanding the platform (Miehé et al., 2022). However, despite these increasing insights on how ecosystem strategy requires unique approaches to managing innovation processes in the ecosystem (e.g., creating new processes, new capabilities, and management mechanisms). We still have limited insights on how strategy in ecosystem settings affects the development of new innovation processes.

Third, a significant stream of innovation processes literature argues that innovation processes are contingent upon strategy (e.g., Ortt and Van Der Duin, 2008; Salerno et al., 2015). For example, firms competing via radical products need to create specific processes to trigger radical innovation (e.g., O'Connor and Rice, 2013). Despite these increasing insights, we still have limited evidence on how strategy in the ecosystem triggers the development of new innovation processes in ecosystems.

Together, these gaps highlight the need for exploring the links between innovation processes in the ecosystem and strategy. More specifically on how the new strategy of firms operating in the ecosystem affects the development of new innovation processes. The model and hypothesis are presented in Figure 8.

5.1 Ecosystem-based strategy and innovation processes

A fundamental implication of the ecosystem as a structure (e.g., Adner, 2017; Jacobides et al., 2018) is different firms in the ecosystems develop new activities and processes according to their role and position. Thus, firms strategizing in ecosystem settings recognize their role in the ecosystem and employ strategies to sustain their positions (Brea, 2023; Gomes et al., 2023). This type of strategy has been labeled an ecosystem-based strategy (Gomes et al., 2013).

A key insight is introduced by Ganco et al. (2020), which investigated how firms in downstream and upstream positions in the ecosystem (i.e., those offering components and complements, respectively) changed their innovation processes according to their position. Interestingly, while firms in the upstream position are concerned with how their components perform, downstream firms are focused on exploring the possibilities of integration of their complements with the components delivered by upstream firms (Ganco et al., 2020).

A recent stream of research is exploring how another element of the ecosystem structure is affecting the development of innovation, the role. Increasing evidence shows that while orchestrators need to deal with the architecture of the ecosystem (e.g., Cennamo and Santaló, 2019; Dattée et al., 2018), complementors employ strategies to make sense of the ecosystem architecture and adapt their processes to address it (e.g., Oskam et al., 2021). Indeed, the role of the firm in the ecosystem affects its potential to innovate since each actor has a responsibility to innovate part of the value proposition (Brea, 2023).

In this perspective, firms adapt their innovation processes according to their roles in a given ecosystem. For example, orchestrator modularize their offerings to allow the contribution of external partners (Stonig et al., 2023). Indeed, the decision to adapt the innovation processes is critical to the platform development (Inue, 2021). For example, decisions regarding the orchestrator assuming a new role in the platform affect the perception that complementors have of the platform (Foerderer, 2020). On the one hand, platform orchestrators modify their processes to allow the coordination of the complementors in the ecosystem and sustain their role as the ecosystem (Cennamo and Santaló, 2019; Dattée et al., 2018). On the other hand, the firm needs to manage its value capture and also recognize what opportunities will be left to the firm and what will be shared with the ecosystem (Murthy and Madhok, 2021).

Thus, firms concerned with sustaining their position in the ecosystem need to create specific processes, thus I propose that:

H1a: Ecosystem-based strategy positively affects the ecosystem-based innovation processes;

Beyond sustaining their position either as a leader or a complementor, firms operating in ecosystems seek to "succeed in a particular ecosystem" (Gomes et al., 2023, p. 544). Despite the ecosystem being composed of independent actors that are often hierarchically loose from the focal firm (Adner, 2017), firms in the ecosystem are coordinated by specific actions of the focal firm that orchestrates them towards the collective value proposition (e.g., Linde et al., 2021).

The success of the ecosystem depends on its capability to generate new ideas and transform them into innovations (Overholm, 2015). In this sense, the ecosystem provides a pool of resources in the form of actors, technology, and knowledge, which actors can explore to increase their value creation in the ecosystem (e.g., Hurni et al., 2021). Orchestrators deploy these resources to facilitate and trigger the innovation of complementors that engage in value creation (e.g., Schreieck et al., 2021).

Additionally, a central feature of the ecosystem is the notion of interdependence, which highlights how innovation is more valuable together than offered by individual firms (Jacobides et al., 2018). Indeed, firms in the ecosystem benefit from interdependence in multiple ways. For example, in SAP's ecosystem, complementors have access to its sales channels and market reputation (e.g., Schreieck et al., 2021). Additional research has explored how complementors participating in events or awards ceremonies increased their innovation performance (Foerderer, 2020).

Thus, firms aiming to sustain their role and succeed in the ecosystem engage with the collective constellation of actors in the ecosystem to create value and compete against rival ecosystems. Thus, I propose that:

H1b: Ecosystem-based strategy positively affects the innovation processes within the ecosystem;

The ecosystem does not emerge automatically; firms need to build specific mechanisms and structures (e.g., Kolagar et al., 2022; Thomas et al., 2022). In this perspective, firms create specific activities that enable an ecosystem's development. In insightful research, Kolagar et al. (2022) found that firms moving from standalone products to an ecosystem of collective offerings start the process by enabling an integrative platform that combines the offerings of the firm into components that can be matched with offers of complementors. Similarly, Kolagar et al. (2022) argue that one of the antecedents of the transformation towards an ecosystem is the changes in the business model.

Indeed, firms that want to maintain their role in the ecosystem create mechanisms to attract new partners to the platform (Jacobides, 2022). There needs to be clearly stated what the roles of each individual actor are and what they will gain from the ecosystem (Thomas et al., 2022).

These activities related to the ecosystem structure are not exclusive to the orchestrators. Complementors, for example, might use new technologies to connect themselves to other platforms, which will then allow the expansion of the ecosystem structure (Miehé et al., 2023).

Overall, new research is providing increasing evidence that firms that want to sustain their role and succeed in an ecosystem are creating specific processes to address the ecosystem structure (Jacobides, 2022; Thomas et al., 2022); thus, I propose that:

H1c: Ecosystem-based strategy positively affects the ecosystem structure innovation processes;

5.2 Ecosystem strategy and innovation processes

H1a, H1b, and H1c have discussed how firms aiming to sustain their role and succeed in a certain ecosystem build new or adapt existing innovation processes.

Firms in the ecosystem face the significant challenge of allowing the continuous development of innovation in the platform. Innovation drives the ecosystem forward but is also a source of continuous change (e.g., Breslin, 2021). During the development of the ecosystem, some complementors might stop providing quality complementors or offers that do not fit the value proposition of the ecosystem (e.g., Holgersson et al., 2022).

Given the competition between ecosystems, firms must ensure that the ecosystem remains healthy (Cobben et al., 2023) and provide superior innovation to compete with rival ecosystems (Gomes et al., 2023; Kolagar et al., 2022). In this perspective, the focal firm may need to establish specific mechanisms to ensure that the ecosystem remains competitive.

For example, if the focal firm increases the degree of modularization to attract new partners (Stonig et al., 2022), the ecosystem will need to attract new partners with individual innovation processes (i.e., ecosystem-based innovation processes) to fill the platform void. However, if the firm is unable to attract quality partners, they have either to assume the role of complementors (i.e., changing their ecosystem-based innovation processes) or the value proposition will be weakened (e.g., Malherbe and Tellier, 2022).

In this perspective, firms facing the competition of ecosystem vs ecosystem face the challenge of developing new ecosystem-based innovation processes to ensure a competitive advantage and succeed against rival ecosystems; thus, I propose that:

H2a: Ecosystem strategy positively affects the ecosystem-based innovation processes;

In the innovation ecosystem, firms face the challenge of competing via the complementary offers of other firms that are independent but have to be aligned for the materialization of the systemic value proposition (e.g., Adner, 2017). Indeed, a key feature of the ecosystem is the notion of generativity, which refers to "the capacity to produce unprompted change driven by large, varied, and uncoordinated audiences" (Zittrain, 2006, p. 1980).

In this perspective, firms create new processes to align and coordinate these ecosystem partners and guide them toward the collective value proposition (Linde et al., 2021; Malherbe and Tellier, 2022; Schreieck et al., 2021). For example, firms might signal opportunities for the development of innovation for complementors (Hukal et al., 2020). Additionally, when facing competition or moving towards new platform sides, firms might share boundary resources with the partners to steer them in the development path (e.g., Fink et al., 2020) and ensure the quality of the innovation that will compete with rival ecosystems (Hilbolling et al., 2021; Huang et al., 2021).

Overall, research suggests that firms competing with rival ecosystems build unique mechanisms for the constellation of actors in the ecosystem to create value superior to rival ecosystems; thus, I propose that:

H2b: Ecosystem strategy positively affects the innovation processes within the ecosystem;

The ecosystem is constantly changing due to competition, and firms are building unique mechanisms to identify the need to change the ecosystem structure (Holgersson et al., 2002; Kolagar et al., 2022). These processes include multiple activities related to assessing the ecosystem health (Cobben et al., 2023), identifying the need to add or replace actors (Kolagar et al., 2022), and changing the value proposition (Oskam et al., 2021).

Additionally, firms are often modifying the ecosystem value proposition (Oskam et al., 2021) and openness (Benlian et al., 2015; Inoue, 2021; Parker and Van Alstyne, 2018) to attract new partners or ensure only the entry of high-quality applicants.

Overall, research argues that ecosystem competition drives the ecosystem to constantly evaluate the structure and create new processes to transform it; thus, I propose that:

H2c: Ecosystem strategy positively affects the ecosystem structure innovation processes;

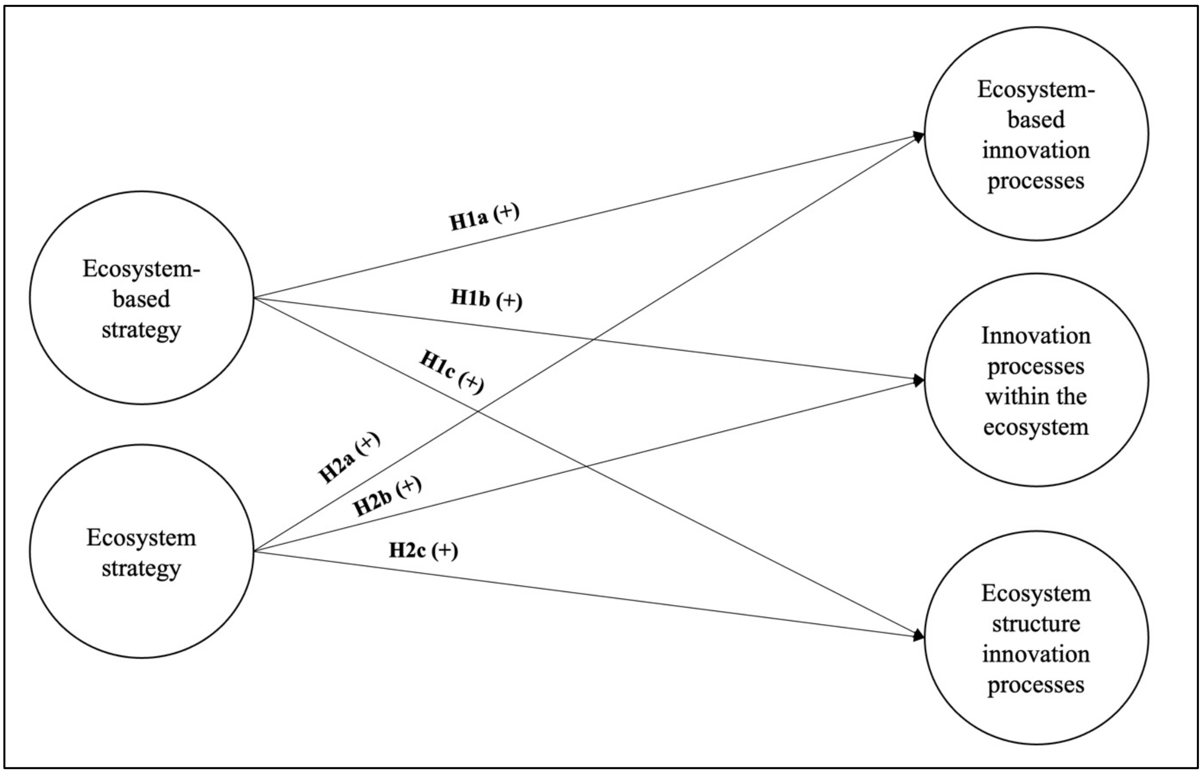

Figure 8. Model and hypothesis

6 METHOD

6.1 Research Design

Structural equation modeling (SEM) is a methodology designed to analyze complex interactions between variables and test structural model relationships (e.g., Hair et al., 2017; Hair et al., 2018). Some variations of this method intend to solve the issue of complex interactions but employ different principles. The most used by scholars are covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM) (e.g., Hair et al., 2017). The objective of CB-SEM is to "estimate model parameters that minimize the differences between the observed sample covariance matrix" (Hair et al., 2017, p. 109), while PLS-SEM focuses on maximizing the "the variance explained in the dependent variable(s)" (Hair et al., 2017, p. 109). Given the different assumptions between the methods, scholars have argued that there are multiple reasons to choose one method over another (e.g., Hair et al., 2017). For example, PLS-SEM is very suitable when the focus of the research is on testing a theoretical framework by focusing on the prediction aspect (Hair et al., 2018). Indeed, in situations where the focus is on exploratory research centered on theory development by understanding prediction mechanisms, PLS-SEM is a powerful tool (Hair et al., 2017).

Recent studies in the field of innovation, strategy, and entrepreneurship have been using SEM as a research methodology (e.g., Marzi et al., 2023; Ukobitz and Faullant, 2022); particularly, PLS-SEM has been used in a myriad of research in top journals (e.g., Technovation, Research Policy, and Strategic Management Journal). Recent applications include understanding the triggers of radical innovation adoption (Ukobitz and Faullant, 2022) and exploring cognitive configurations that affect the adoption of open innovation in SMEs (Marzi et al., 2023). These studies argue that PLS-SEM is useful for exploratory research, particularly when the theory is still in its infancy (Ukobitz and Faullant, 2022). Thus, in the context of ecosystem research, particularly in understanding how ecosystem strategy affects the development of innovation processes, PLS-SEM is a suitable method for understanding the prediction relationships and contributing to theory building (in line with Hair et al., 2017).

6.2 Sampling, survey, and data collection

The sampling process followed a structured protocol to ensure the validity and reliability of our data collection to proceed to the analysis. First, we used G*Power to estimate the initial minimum sample size. G*Power is useful for estimating the minimum sample size (Ringle et al., 2014). Following Hair et al. (2014)'s guidelines, I defined the power as 0.95 and effect size $f^2 = 0.15$. Figure 9 shows the minimum sample size that this research should aim.

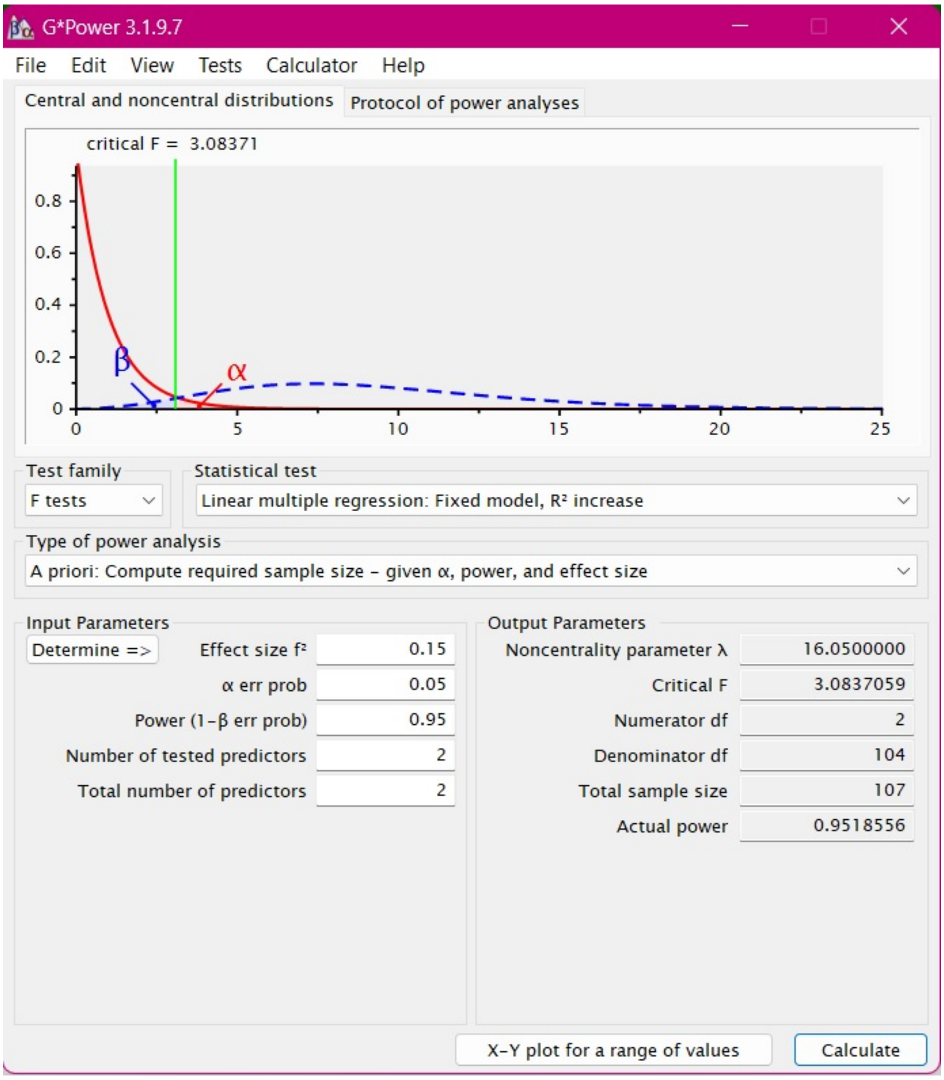

Figure 9. Minimum sample size G*Power

Data was collected using a survey applied with CEOs, vice-presidents, innovation managers, open innovation managers, project managers, and community managers, among others involved in ecosystem management. The questionnaire had multiple questions related to different aspects of ecosystem management, more specifically, the questions related to ecosystem strategy and innovation processes in ecosystem settings (Table 7). The survey was conducted using the SurveyMonkey platform and shared with these participants via LinkedIn, workshops, and individual contacts. The questions were framed as a closed-ended 5-point

Likert scale with "1" representing "completely disagree" and "5" being "completely agree". The survey was online between August and December of 2022.

Number of Workers	Number of firms	Percentage
1 - 10	28	11%
11 - 50	22	8%
51 - 100	28	11%
101 - 500	40	15%
Above 500	147	55%

Table 3. Number of workers per firm

A total of 629 respondents engaged in responding to the survey; however, only 275 had answered most of the questions entirely. I performed an exploratory statistical analysis to investigate the number of missing values in the sample. This stage highlighted those seven respondents had over 10% missing values, which was then defined as a cutoff point. I excluded all the answers with over 10% of incomplete responses, resulting in a final sample of 268 respondents. Tables 3, 4, and 5 present the characteristics of the sample.

Job Title	Number	Percentage
Analyst	17	9%
Innovation Analyst	20	10%
Business Architect	1	1%
CEO (Chief Executive Officer)	14	7%
CFO (Chief Financial Officer)	9	5%
Chief Product Officer	1	1%
Community Builder	1	1%
Community Manager	1	1%
Consultant	4	2%
Innovation Consultant	1	1%
COO (Chief Operating Officer)	3	2%
Coordinator	17	9%
Innovation Coordinator	39	20%
CTO (Chief Technology Officer)	2	1%

Ecosystems Developer	1	1%
Director	2	1%
Intern	1	1%
Founder	3	2%
Manager	11	6%
Innovation Manager	2	1%
Manager of Partnerships and Open Platforms	1	1%
Ecosystem Product Manager	1	1%
Senior Manager	1	1%
Project Manager	5	3%
Researcher	4	2%
Managing Director	4	2%
VP Sales	1	1%
Others	29	15%

Table 4. Jobs of the respondents

Industry Sector	Number of Firms	Percentage
Agribusiness	15	6%
Consumer Goods and Food	12	5%
Civil Construction / Building and Construction	5	2%
Electric Power / Electricity	3	1%
Renewable Energy	2	1%
Real Estate Sector	4	2%
Automotive Industry	10	4%
Electromechanical Industry	3	1%
Chemical Industry	6	2%
Textile Industry	3	1%
Minerals and Metals	5	2%
Other Sector	53	20%
Pulp and Paper	3	1%
Oil and Gas	4	2%
Health and Wellness	12	5%
Sanitation	2	1%
Insurance	6	2%
Education Services	12	5%
Health Services	8	3%
Financial Services	42	16%

Professional Services	21	8%
Software	18	7%
Telecommunications	7	3%
Transportation and Logistics	4	2%
Retail and Distribution	6	2%

Table 5. Sectors

6.3 Data analysis

Data analysis followed a structured and systematic process based on specialized literature on PLS-SEM (e.g., Hair et al., 2014; Ringle et al., 2014) and peer-reviewed articles that have employed this methodology (e.g., Ukobitz and Falluant, 2022). Data analysis was based on three main stages: descriptive statistics, measurement model assessment, and structural model assessment (Table 6).

The descriptive statistic had the goal of gathering a general understanding of the original sample and allowing the identification of the measures of central tendency and dispersion. This stage allowed the identification of initial clues about the respondent's perceptions of ecosystem strategy and innovation processes in ecosystems.

Following Hair et al. (2014)'s recommendations, I divided the analysis of the structural model into two parts. First, I assessed the reflective measurement models by identifying internal consistency, convergent validity, and discriminant validity. Internal consistency was measured using Cronbach's alpha and composite reliability with reference values of > 0.7 (Hair et al., 2014). I then assessed the constructs' convergent validity by analyzing the outer loadings and AVE using the Fornel-Larcker criterion with AVE > 0.5 (Fornell-Larker, 1981). Lastly, I calculated the discriminant validity of the constructs to ensure empirical differentiation among them using the Fornell-Larker criterion and the heterotrait-monotrait ratio (HTMT). After ensuring the internal consistency and validity of the measurement model, I proceeded to assess the structural model.

Data Analysis	Indicators	References
Measurement model assessment	• Internal consistency (Cronbach's alpha, composite reliability) • Convergent validity (outer loadings and average variance explained – AVE) • Discriminant validity (Fornell-Larker criterion and	Hair et al., (2014); Ringle et al., (2014);

	heterotrait-monotrait ratio (HTMT)	
Structural model assessment	• Coefficients of determination (R^2) • Predictive relevance (Q^2) • f^2 effect sizes • Size and significance of path coefficients	Cohen (1998); Hair et al. (2014); Ringle et al. (2014)

Table 6. Data analysis procedures

The evaluation of the structural model was centered on three main stages. First, I calculated the coefficients of determination (R^2), which allowed the identification of the explanatory power of the model. Then, I moved to identify the predictive relevance and f^2 effect sizes of the model. Lastly, I proceeded to identify the path coefficients of the hypothesis and identify the significance of each relationship.

6.4 Measurement instruments

After defining the research objectives and the most suitable method to address them, I investigated how to operationalize the constructs to use in a quantitative study. While the ecosystem literature is increasing and multiple research designs are being employed (Gomes et al., 2022), most research focused on uncovering the mechanisms of ecosystem management are still primarily exploratory (e.g., Cobben et al., 2023; Linde et al., 2021) and concentrate on theory-building rather than theory-testing. Thus, capturing measurement indicators to understand the effects of ecosystem strategy on innovation processes in ecosystems is a challenging task. Thus, I proceeded to investigate the current literature for the appropriate constructs and opportunities to operationalize them in a survey.

The measurement instrument was developed both by adapting previous constructs developed with empirical studies (e.g., Gomes et al., 2022, 2023) and via the constructs identified with the systematic literature review (e.g., ecosystem-based innovation processes, innovation processes within the ecosystem, and ecosystem structure innovation processes). This first stage for identifying the items for the measurement instrument was focused on the framework developed by the extensive literature on innovation processes and ecosystem settings (sections 3-4). I used the review to capture the underlying mechanisms of each innovation process. Additionally, I reviewed the ecosystem literature focused on strategy (e.g., Gomes et al., 2023; Hannah and Eisenhardt, 2019; Kretschmer et al., 2022; Rietveld et al., 2019; Rietveld et al., 2021) to uncover the mechanisms to measure ecosystem strategy. The items used in this research are presented in the table below (Table 7).

The construction of the measurement instruments was conducted in multiple rounds of development and peer review to ensure face and construct validity. First, an initial set of items was created to operationalize the constructs (e.g., ecosystem-based strategy, ecosystem strategy, ecosystem-based innovation processes, innovation processes within the ecosystem, and ecosystem structure innovation processes) in multiple scale items. This initial set was scrutinized by peers specialized in ecosystem and innovation management literature. This review process was fundamental to refine the items and add more clarity to the measurement instruments.

A second round of review was performed with a revised set of constructs. In this second round, a few modifications were made and mostly focused on increasing the clarity of the writing of each of the items. Then, we proceeded to a test application of the survey focused on professionals in the area of ecosystem and innovation management with the purpose of gathering insights into our set of items. The stage was fundamental to capture: 1) the need to reduce the number of items in the survey to facilitate the response rate, 2) revising the clarity of the writing in specific items.

Construct	Variable code	English Version	Original Version	Source
Ecosystem-based strategy	EST-EBE1	My firm works to ensure your strategic positioning within your business ecosystem	Minha firma atua para garantir o seu posicionamento estratégico em seu ecossistema de negócios	Derived from construct developed by Gomes, L. A. D. V., Hourneaux Junior, F., Facin, A. L. F., & Leal, L. F. (2023). Performance measurement and management systems for dealing with strategies in uncertain ecosystems. *International Journal of Operations & Production Management*, *43*(3), 543-577.
	EST-EBE2	My firm works to expand the range of product and service offerings within your business ecosystem	Minha firma atua para uumentar os tipos de ofertas de produtos e serviços para o seu ecossistema de negócios	
	EST-EBE3	My firm works to prevent partners from taking the lead in the business ecosystem	Minha firma atua para evitar que os parceiros assumam a liderança no ecossistema de negócios	
Ecosystem strategy	EST-EE1	My firm takes a leadership role in the ecosystem to ensure that the business ecosystem offers better products and services than rival business ecosystems	Minha firma atua na liderança do ecossistema para que o ecossistema de negócios ofereça produtos e serviços melhores do que os ecossistemas de negócios rivais	
	EST-EE2	My firm takes a leadership role in the ecosystem to align and manage the partners within the business ecosystem in order to offer better products and services than rival business ecosystems	Minha firma atua na liderança do ecossistema para alinhar e gerenciar os parceiros do ecossistema de negócios no intuito de oferecer produtos e serviços melhores que os dos ecossistemas de negócios rivais	
Ecosystem-based innovation processes	EBIP1	In the processes of product and service innovation (idea generation and selection, development, and implementation), my company frequently modifies the development processes to allow other business ecosystem partners to complement the innovation	Nos procesos de inovação de produtos e serviços (busca e seleção de ideias, desenvolvimento e implementação), minha empresa frequentemente modifica os processos de desenvolvimento para permiter que outros parceiros do ecossistema de negócios complementem a inovação	Derived from the systematic literature review on innovation processes in ecosystem settings
	EBIP2	In the processes of product and service innovation (idea generation and selection, development, and implementation), my company often utilizes its own resources (e.g., financial, market access, reputation) to commercialize third-party solutions	Nos procesos de inovação de produtos e serviços (busca e seleção de ideias, desenvolvimento e implementação), minha empresa frequentemente utiliza os recursos (ex: financeiros, acesso ao mercado, reputação) da propria empresa para comercializar a solução de terceiros	
	FGE-RE1	My company frequently controls what specific partners and/or customers can	Minha empresa frequentemente controla o que determinados parceiros e/ou clientes	Derived from constructs developed by Gomes, L. A. V., Facin, A. L. F., Leal, L.

		access in terms of platform/marketplace services or functionalities	podem ter acesso em relação a serviços ou funcionalidades da plataforma/marketplace	F., de Senzi Zancul, E., Salerno, M. S., & Borini, F. M. (2022). The emergence of the ecosystem management function in B2B firms. *Industrial Marketing Management*, *102*, 465-487
	FGE-RE2	My company often controls which partners and customers can access certain services or functionalities of the platform/marketplace	Minha empresa frequentemente controla quais parceiros e clientes podem ter acesso a determinados serviços ou funcionalidades da plataforma/marketplace	
Innovation processes within the ecosystem	IPE1	In the processes of product and service innovation (idea generation and selection, development, and implementation), my company and the ecosystem partners constantly develop roadmaps, tools, and other materials that enable business ecosystem partners to identify new opportunities or gaps in the mix of products and services offered to customers	Nos processos de inovação de produtos e serviços (busca e seleção de ideias, desenvolvimento e implementação), minha empresa e os parceiros do ecossistema constantemente desenvolvem roadmaps, ferramentas e outros materiais que permitem que os parceiros do ecossistema de negócios reconheçam novas oportunidades ou lacunas no mix de produtos e serviços oferecidos aos clientes	Derived from the systematic literature review on innovation processes in ecosystem settings
	IPE2	In the processes of product and service innovation (idea generation and selection, development, and implementation), my company and the ecosystem partners consistently develop methodologies and approaches (e.g., toolkits, co-development spaces, experimentation) to facilitate the process of developing new products and services by business ecosystem partners	Nos processos de inovação de produtos e serviços (busca e seleção de ideias, desenvolvimento e implementação), minha empresa e os parceiros do ecossistema constantemente desenvolvem metodologias e abordagens (ex: toolkits, espaços de codesenvolvimento, experimentação) para facilitar o processo de desenvolvimento de novos produtos eserviços pelos parceiros do ecossistema de negócios	
	IPE3	In the processes of product and service innovation (idea generation and selection, development, and implementation), my company and the ecosystem partners continuously establish distribution and commercialization structures (e.g., marketplaces) to facilitate the diffusion of innovation from business ecosystem partners	Nos processos de inovação de produtos e serviços (busca e seleção de ideias, desenvolvimento e implementação), minha empresa e os parceiros do ecossistema constantemente estabelecem estruturas de distribuição e comercialização (ex: marketplaces) para facilitar a difusão da inovação dos parceiros do ecossistema de negócios	

Ecosystem structure innovation processes	ESIP1	When my company and the ecosystem partners modify the scope of the product mix offered to customers (e.g., new features, new services), they need to change the roles within the business ecosystem (e.g., new types of partners to perform these new functionalities)	A minha empresa e os parceiros do ecossistema ao modificar o escopo do mix de produtos oferecidos aos clientes (ex: novas funcionalidades, novos serviços), precisam alterar os papéis do ecossistema de negócios (ex: novos tipos de parceiros para desempenhar essas novas funcionalidades)	
	ESIP2	My company and the ecosystem partners produce innovations to generate new capabilities, technologies, and unique roles in order to offer a superior solution to compete with rival business ecosystems	A minha empresa e os parceiros do ecossistema produzem inovações para gerar novas capacidades, tecnologias e papéis únicos no intuito de ofertar uma solução superior para concorrer com ecossistemas de negócios rivais	

Table 7. Operationalization of constructs

The *ecosystem-based strategy* construct was measured using three items (EST-EBE1, EST-EBE2, EST-EBE3) and was derived from a construct developed by Gomes et al. (2023). Taken together, the construct captures the "set of activities by which a firm pursues creating an advantage, secures its role, and succeeds in a particular ecosystem" (Gomes et al., 2023, p. 544). Interestingly, this strategy recognizes the ecosystem structure as central to how the firms deploy their strategy and focus on how the firm aims to sustain their role in ecosystem (either as an orchestrator or a complementor).

The *ecosystem strategy* construct was measured using two items (EST-EE1, EST-ES2) and was derived from a construct developed by Gomes et al. (2023). The construct captures the "set of activities by a group of autonomous yet interdependent actors that deliver a value proposition to clients attempting to create advantage and succeed against rival ecosystems" (Gomes et al., 2023, p. 544). Different from the ecosystem-based strategy (a firm-level strategy), the locus of ecosystem strategy is the ecosystem and is focused on the constellation of actors in the ecosystem.

The *ecosystem-based innovation processes* construct was measured using five items and was derived from the systematic literature review on innovation processes in ecosystem settings (sections 3-4). Together the items capture the firm's journey in adjusting its innovation processes to operate in a given ecosystem.

The *innovation processes within the ecosystem* construct were measured using five items and were derived from the systematic literature review on innovation processes in ecosystem settings (sections 3-4). Together the items capture the collective innovation activities among ecosystem partners performed to deliver value to clients and help to compete against rival ecosystems.

The *ecosystem structure innovation processes* construct was measured using five items and was derived from the systematic literature review on innovation processes in ecosystem settings (sections 3-4). Together the items capture situations in which firms create new or modify the current ecosystem structure (e.g., value propositions, roles, activities, links, and flows).

6.5 Ensuring quality and validity

I employed multiple mechanisms to ensure the quality and reliability of this research's findings. First, the measurement instruments were developed from the extensive literature review on innovation processes in ecosystem settings and previous constructs published in toptier journals (e.g., Gomes et al., 2022; 2023). Beyond ensuring the quality of the source material for the questions, the items were developed in multiple rounds of workshops with scholars specialized in strategy and ecosystem management, as well as colleagues from the graduate school.

By subjecting the items to rigorous scrutiny and employing a meticulous process that considered the constructs' theoretical foundations, I was able to select more appropriate items. This comprehensive scrutiny ensured that the items aligned with established theories (i.e., the previously established concepts and the findings from the systematic review) while enabling the ecosystem management professionals to provide answers effortlessly. The careful consideration of theoretical foundations enhanced the items' validity and reliability and bolstered professionals' confidence in their responses by aiming to make the items more straightforward.

Second, I employ as supporting literature a number of references that provide insightful guidance on how to conduct PLS-SEM research (e.g., Hair et al., 2014; Ringle et al., 2014) and how to report it (e.g., Benitez et al., 2020; Hair et al., 2019). This allows the findings to be more suitable to acceptable standards and also ensures the relevance and reliability of the findings.

Lastly, the theorization process and the hypothesis development were performed with multiple rounds of meetings and workshops, which allowed the continuous sharing of the findings and the enrichment of this research by sharing with expert scholars and other colleagues.

7 FINDINGS

In this section, I present the structural equation modeling analysis results. The descriptive statistics analysis was performed using SPSS, and the PLS-SEM used the SmartPLS software (SmartPLS 4). This section is divided into four subsections: descriptive statistics, measurement model assessment, structural model assessment, and hypothesis testing.

7.1 Descriptive statistics

The first stage of the analysis was exploratory statistical analysis (Table 8). The purpose of this first stage was to capture an initial overview of the data and the initial statistics to proceed with further analysis. Regarding the findings, I identified first that the mean of responses on "ecosystem-based strategy" was higher than "ecosystem strategy", which might indicate that firms have higher concerns about ensuring their position in the ecosystem than about competing with rival ecosystems.

Construct	Variable Code	Mean	Median	Std. Deviation
Ecosystem-based strategy	EST-EBE1	4.12	5.00	1.116
	EST-EBE2	4.03	4.00	1.122
	EST-EBE3	3.24	3.00	1.278
Ecosystem strategy	EST-EE1	3.58	4.00	4.00
	EST-EE2	3.58	4.00	1.239
Ecosystem-based innovation processes	EBIP1	3.05	3.00	1.240
	EBIP2	3.05	3.00	1.341
	FGE-RE1	3.44	4.00	1.361
	FGE-RE2	3.54	4.00	1.311
Innovation processes within the ecosystem	IPE1	3.14	3.00	1.262
	IPE2	3.16	3.00	1.318
	IPE3	2.99	3.00	1.284
Ecosystem structure innovation processes	ESIP1	3.02	3.00	1.185
	ESIP2	3.48	4.00	1.182

Table 8. Descriptive statistics

A closer look at the innovation processes shows consistency among the three types of innovation processes. Interestingly, while the meaning of "ecosystem-based strategy" is higher than "ecosystem strategy", this is not identified in the innovation processes. On the contrary, the innovation processes within the ecosystem (i.e., focused on the collective action of actors to materialize a value proposition and competing against rival ecosystem) is higher than the "ecosystem-based innovation processes", which is centered on modifying the innovation processes according to the ecosystem structure (i.e., the roles, and position, among others), and the type of ecosystem (e.g., knowledge ecosystem and entrepreneurial ecosystem.

7.2 Measurement model assessment

After the exploratory statistical analysis, I proceeded to analyze the measurement model (Figure 10). PLS-SEM is analyzed using systematic methods to ensure validity and predictive power. The main goal of PLS-SEM is to maximize the explained variance (R^2) of the endogenous variables; thus, the focus is on the metrics indicating the model's predictive power (Hair et al., 2014). Following specialized literature, I followed Hair et al. (2014) recommendations for organizing analysis by 1) assessing the measurement model and 2) evaluating the structural model. In this section, I describe the results from the measurement model assessment, the purpose was to ensure that the constructs and indicators were valid and reliable to proceed to investigate the structural model.

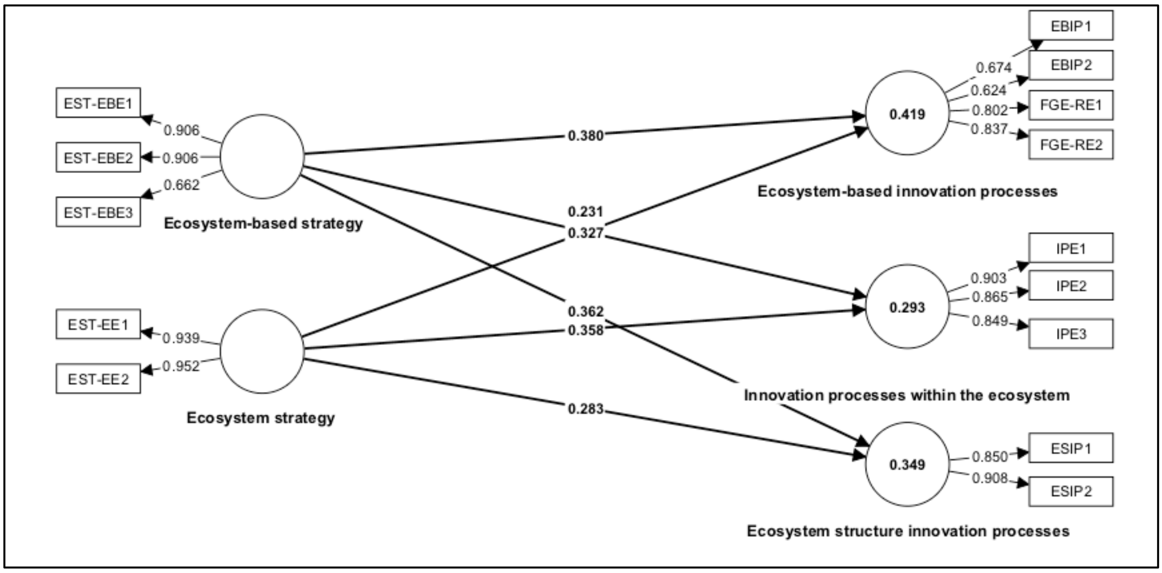

Figure 10. Measurement model assessment

Figure 10 shows the initial model following the theoretical model established in this research. Following Hair et al. (2014)'s guidelines, I investigated the measurement model's internal consistency (Table 9). First, I assessed the items' outer loadings. In this stage, items with very low outer loading (<0.40) should be removed from the constructs, and items with low loadings (0.4-0.7) should be evaluated if their impact affects the composite reliability and content validity (Hair et al., 2017). In this stage, the items' outer loadings were all above .06, I then proceeded to investigate another measure of convergent validity.

After estimating the outer loadings, I proceeded to calculate the constructs' convergent validity. Convergent validity is how a measure correlates positively with alternative other measures in the same construct (Hair et al., 2014). Beyond using the indicators' outer loadings, convergent validity also considers the average variance extracted (AVE). A commonly accepted measure is that each latent variable (construct) should explain at least 50% of each indicator's variance (Hair et al., 2014). In this sense, I employed Fornell and Larcker (1981)'s method, considering that AVE should be higher than 0.5. As shown in Table 9, all of the latent variables in this research have an AVE > 5, which indicates that the model converges satisfactorily (Ringle et al., 2014). I, therefore, proceeded to calculate the model's reliability.

The reliability of the constructs I used in this research was measured using Cronbach's Alpha and Composite Reliability (CR). Cronbach's alpha uses the intercorrelations of the observed variables to estimate the reliability (Hair et al., 2014). Although a commonly used method, Cronbach's alpha is sensitive to the number of items and might underestimate internal consistency reliability (Ringle et al., 2014); thus, I also used composite reliability to ensure that internal consistency was properly measured. All the constructs exceeded the acceptable value for Cronbach's alpha (>0.7; Hair et al., 2014). Composite reliability follows a similar pattern to Cronbach's alpha, with acceptable values ranging from 0.6 to 0.7 for exploratory research, while for more confirmatory studies, 0.7 to 0.9 values are acceptable. As shown in Table 9, composite reliability values were all above the acceptable values for exploratory and studies in more advanced stages of research (>0.8; Hair et al., 2014). After ensuring that the latent variables were reliable, I assessed the latent variables' discriminant validity.

Construct	Variable	Loading	AVE	Composite reliability (rho_c)	Cronbach's alpha
Ecosystem-based strategy	EST-EBE1	0.904	0.693	0.869	0.769
	EST-EBE2	0.904			
	EST-EBE3	0.662			
Ecosystem strategy	EST-EE1	0.939	0.895	0.944	0.882
	EST-EE2	0.952			
Ecosystem-based innovation processes	EBIP1	0.674	0.547	0.826	0.716
	EBIP2	0.624			
	FGE-RE1	0.802			
	FGE-RE2	0.837			
Innovation processes within the ecosystem	IPE1	0.903	0.761	0.905	0.843
	IPE2	0.865			
	IPE3	0.849			
Ecosystem structure	ESIP1	0.850	0.774	0.873	0.712
	ESIP2	0.908			

innovation processes					

Table 9. Internal consistency of reflective constructs

Discriminant validity investigates whether the latent variables are empirically independent of each other (Hair et al., 2014; Ringle et al., 2014). There are different approaches to calculating discriminant validity. In this research, I employ the Fornell-Lacker criterion and the heterotrait-monotrait ratio (HTMT). The Fornell-Lacker criterion compares the square root of AVE with the correlation of the latent variables (Hair et al., 2014). As shown in the table below (Table 10), the square root of the AVE (in the diagonals) should be higher than the correlations with the other constructs (Ringle et al., 2014).

	Ecosystem strategy	Ecosystem structure innovation processes	Ecosystem-based strategy	Ecosystem-based innovation processes	Innovation processes within the ecosystem
Ecosystem strategy	**0.946**				
Ecosystem structure innovation processes	0.527 (0.658)*	**0.880**			
Ecosystem-based strategy	0.674 (0.817)*	0.553 (0.732)*	**0.833**		
Ecosystem-based innovation processes	0.583 (0.732)*	0.534 (0.763)*	0.600 (0.814)*	**0.739**	
Innovation processes within the ecosystem	0.514 (0.588)*	0.609 (0.797)*	0.473 (0.580)*	0.603 (0.787)*	**0.873**

Table 10. Discriminant validity

Note. * HTMT criteria

Table 10 shows that the Fornell-Lacker criterion was achieved. Despite ensuring discriminant validity using the Fornell-Lacker criterion, research is showing that the heterotrait-monotrait ratio (HTMT) is a more suitable approach to calculating discriminant validity (see. Hair et al., 2014; Ukobitz and Faullant, 2022). The reference value of the HTMT criterion is 0.9, and values above this reference show a lack of discriminant validity (Hair et al., 2014). As table 10 shows, discriminant validity was achieved using both criteria. After discriminant validity was ensured, I proceeded to evaluate the structural model.

7.3 Structural Model Assessment

The structural model (Figure 11) was employed to investigate the six hypotheses proposed by this research. All the hypotheses were confirmed in the PLS-SEM.

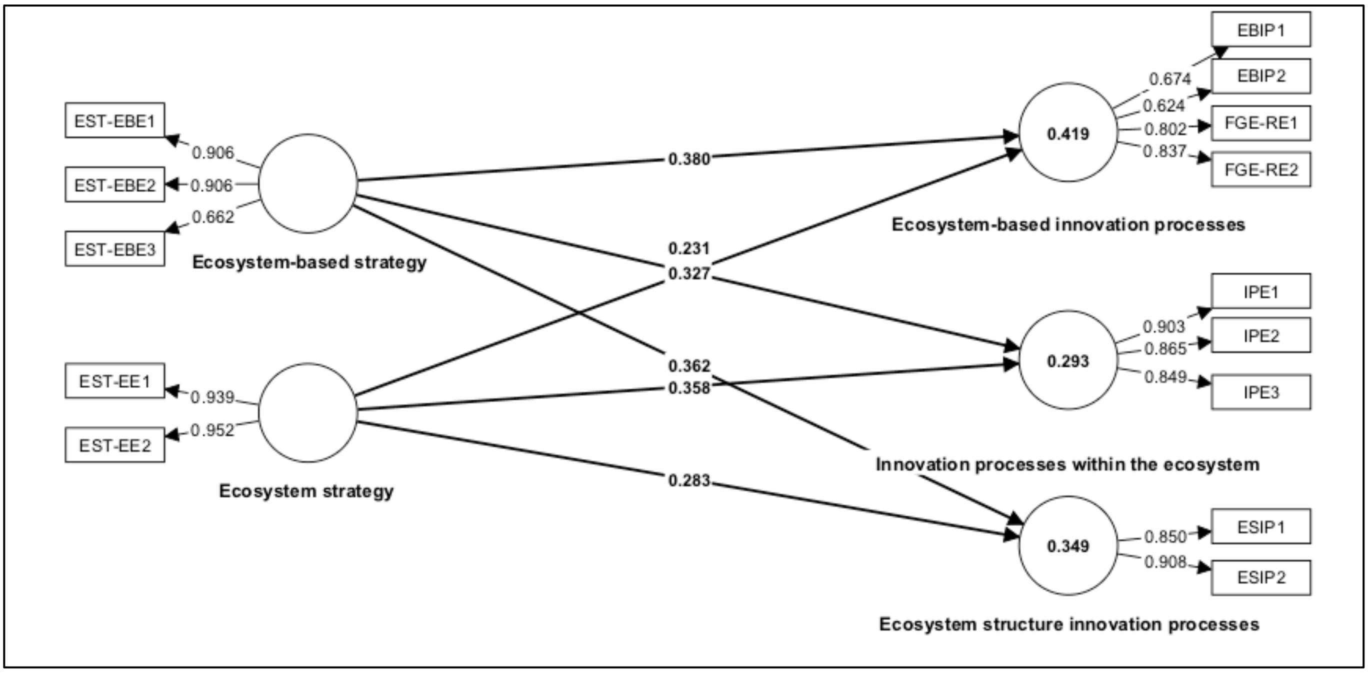

Figure 11. Structural model assessment (n=10.000 bootstrapped samples)

The first step in evaluating the structural model was the coefficients of determination (R^2). For the behavioral and social sciences, acceptable values range from $R^2 = 2\%$ as a small effect, $R^2 = 13\%$ as a medium effect and $R^2 = 26\%$ as a large effect (Cohen, 1998). As Table 11 shows, the model is able to explain 41,4% of the variance of the ecosystem-based innovation processes. This is a large effect, particularly considering that other features of the ecosystem beyond the strategy (e.g., ecosystem management function, digital platforms, management team, organizational structure) could further explain variances in the innovation processes in ecosystems.

Construct	**R-square adjusted**
Ecosystem-based innovation processes	0.414
Innovation processes within the ecosystem	0.288
Ecosystem structure innovation processes	0.344

Table 11. Coefficients of determination (R^2)

Additionally, the innovation processes within the ecosystem variance are explained 28,8% (large effect) by this research's model; similar to the ecosystem-based innovation processes, additional variables can explain more of the construct variance. Lastly, the variance of the ecosystem structure innovation processes is 34,4% explained by the model.

Beyond evaluating the R^2 of the endogenous construct, I also estimated the f^2 effect size of the constructs (Table 12). This measure is helpful in investigating whether, if an exogenous construct were excluded, it would have a significant impact on the endogenous constructs (Hair et al., 2014). The values range from 0.02, 0.15, and 0.35 to represent small, medium, and large effects, respectively.

	Ecosystem structure innovation processes	Ecosystem-based innovation processes	Innovation processes within the ecosystem
Ecosystem Strategy	0.067	0.100	0.099
Ecosystem structure innovation processes			
Ecosystem-Based Strategy	0.110	0.135	0.041
Ecosystem-based innovation processes			
Innovation processes within the ecosystem			

Table 12. Effect size f^2

Lastly, I examined the predictive relevance (Q^2) (Table 13). The reference value is >0, which would indicate that the model has predictive relevance. This measure was calculated using the PLSPredict algorithm in SmartPLS 4. As shown in table x, predictive relevance was established.

Endogenous construct	**Q^2 Predict**
Ecosystem-based innovation processes	0.336
Innovation processes within the ecosystem	0.404
Ecosystem structure innovation processes	0.281

Table 13. Predictive relevance (Q^2)

After ensuring that the model has enough explanatory and predictive power. I proceeded to investigate each individual hypothesis.

7.4 Hypothesis testing

The six hypotheses tested via the structural model (H1a, H1b, H1c, H2a, H2b, and H2c) were confirmed with statistical significance (Table 14).

Hypothesis	Relationships among the constructs	Confirmed?	Beta	T-value	P-value
H1a	Ecosystem-based strategy positively affects the ecosystem-based innovation processes	Confirmed	0.380	5.527	0.000*
H1b	Ecosystem-based strategy positively affects the innovation processes within the ecosystem	Confirmed	0.231	3.188	0.001*
H1c	Ecosystem-based strategy positively affects the ecosystem structure innovation processes	Confirmed	0.362	4.978	0.000*
H2a	Ecosystem strategy positively affects the ecosystem-based innovation processes	Confirmed	0.327	4.482	0.000*
H2b	Ecosystem strategy positively affects the innovation processes within the ecosystem	Confirmed	0.358	4.780	0.000*
H2c	Ecosystem strategy positively affects the ecosystem structure innovation processes	Confirmed	0.283	3.418	0.001*

Table 14. Hypothesis testing

Note. * Significant at $P < 0.001$

H1a hypothesizing that ecosystem-based strategy positively affects the ecosystem-based innovation processes was confirmed ($\beta = 0.380$, $p= 0.000$). Indicating that the ecosystem-based strategy is a contingency that explains the development of adapted processes according to the position of the firm and type of ecosystem (ecosystem-based innovation processes).

H1b hypothesizing that ecosystem-based strategy positively affects the innovation processes within the ecosystem was confirmed ($\beta =0.231$, $p= 0.001$). Indicating that the ecosystem-based strategy is a contingency that explains that firms operating in ecosystems engage in collective processes of value creation within the ecosystem (the innovation processes within the ecosystem)

H1c hypothesizing that ecosystem-based strategy positively affects the ecosystem structure innovation processes was confirmed (β =0.362, p= 0.000). Indicating that the ecosystem-based strategy is a contingency that explains the development of specific processes to create, transform, and innovate ecosystems.

H2a hypothesizing that ecosystem strategy positively affects the ecosystem-based innovation processes was confirmed (β = 0.327, p= 0.000). Indicating that the ecosystem strategy is a contingency that explains the development of adapted processes according to the position of the firm and type of ecosystem (ecosystem-based innovation processes).

H2b hypothesizing that ecosystem strategy positively affects the innovation processes within the ecosystem was confirmed (β = 0.358, p= 0.000). Indicating that the ecosystem-based strategy is a contingency that explains that firms operating in ecosystems engage in collective processes of value creation within the ecosystem (the innovation processes within the ecosystem).

H2c hypothesizing that ecosystem strategy positively affects the ecosystem structure innovation processes was confirmed (β = 0.283, p=0.001). Indicating that the ecosystem-based strategy is a contingency that explains the development of specific processes to create, transform, and innovate ecosystems.

8 DISCUSSION

The results from this research confirm that new strategies aimed at addressing the ecosystem trigger the emergence of adaptation in the current innovation processes or even the emergence of new innovation processes. Despite previous research recognizing the role of strategy in the ecosystem (e.g., Gomes et al., 2023; Hannah and Eisenhardt, 2019; Kretschmer et al., 2022; Rietveld et al., 2019; Rietveld et al., 2021) and how innovation processes differ in ecosystem settings (e.g., Ganco et al., 2018), research has yet to explore these dimensions together, and more specifically, to take into an integrative perspective how the strategy in ecosystem settings may require firms to transform their innovation processes. Below, I discuss the results of the hypothesis test.

8.1 Ecosystem-based Strategy and Innovation Processes

The first hypothesis was confirmed which argued that ecosystem-based strategy positively influences ecosystem-based innovation processes ($\beta = 0.380$, $p = 0.000$). This interesting result illustrates how firms that want to guarantee their role and succeed in the ecosystem build and adapt their innovation processes according to their role in the ecosystem and the type of ecosystem they want to engage with. This result is aligned with recent innovation literature that shows different approaches to innovation processes according to the role (e.g., Cenamor, 2021). For example, complementors have unique opportunities to create a competitive advantage by exploring the platform and its resources (Cenamor, 2021), while orchestrators deal with issues of modularizing the systemic innovation to allow the addition of complementors' innovations (Tee, 2019). This research's findings show that the ecosystem-based strategy, which is focused on guaranteeing the role in the ecosystem (Gomes et al., 2023) is an important predictor of this type of process.

Interestingly, the ecosystem-based innovation process also reflects the individual firms' journey in adapting their processes to engage with different ecosystems. While we have increasing evidence that firms engage with entrepreneurial ecosystems (e.g., Breznitzet et al., 2018; Decreton et al., 2021) and knowledge ecosystems (e.g., Audretsch and Link, 2019), the current literature still lacks insights into how strategy shapes the decision to engage in these ecosystems. For example, Decreton et al. (2021) show that firms engage with innovative startups as a way to recognize new opportunities for innovation. However, our findings show the possibility that firms change their processes to engage with different ecosystems to sustain their role in the ecosystem. This is particularly interesting considering the decisions that individual complementors make within the platform, such as deciding where the complementor will diffuse their innovation (Tavalaei and Cennamo, 2021). The findings from this research highlight that complementors might engage with different ecosystems to sustain their role within another ecosystem. Finally, research is exploring how complementors engaging with different ecosystems affect the expansion of a platform (e.g., Hilbolling et al., 2019). Our findings illustrate that this specific decision might be triggered by an ecosystem-based strategy of focusing on guaranteeing the role and succeeding within the ecosystem (Gomes et al., 2023).

The second hypothesis explored how ecosystem-based strategy influenced the innovation processes within the ecosystem. The results from the structural model confirmed this relationship ($\beta = 0.231$, $p = 0.001$). Overall, despite guaranteeing their role in the ecosystem, firms operating in this setting also want to succeed in providing their innovations to the ecosystem (Gomes et al., 2023), thus, they also engage with the constellation of ecosystem actors to benefit from the synergies and interdependencies among the ecosystem actors. This finding illustrates the unique dynamic of the ecosystem, despite focusing on guaranteeing their role within the ecosystem either as a leader or an orchestrator, firms also must cooperate to generate a superior collective output (e.g., Hannah and Eisenhardt, 2018).

Findings from the literature show that the 'innovation processes within the ecosystem' focus on the polling of resources and the collective innovation activities (e.g, Zapadka et al., 2022). In this sense, this research's findings show that firms aiming to guarantee their role engage with the ecosystem resources and collective innovation activities. This is particularly interesting since it has been documented by previous literature how the ecosystem provides opportunities for complementors to recognize new opportunities (e.g., Murthy and Madhok, 2021; Overholm, 2015) and facilitate innovation via the use of technological toolkits (e.g., Ozalp et al., 2018). Indeed, our findings illustrate that the individual decision to guarantee the role in the ecosystem affects how firms will engage in these activities aimed at generating generativity. Generativity is a key concept of the ecosystem and refers to the capacity of the ecosystem "to produce unprompted change driven by large, varied, and uncoordinated audiences" (Zittrain, 2006, p. 1980). This research's findings add to this literature by recognizing the role of individual actors in engaging in a generative system to co-create value (in line with Thomas and Tee, 2021). This finding suggests that the strategic decision of firms in the ecosystem to maintain their position triggers collective engagement in activities within the ecosystem.

Additionally, a key feature of the ecosystem is interdependence (Jacobides et al., 2018), which refers to the value of a solution being higher when combined with complementary offerings than individually. Our findings show that firms wanting to succeed in an ecosystem might recognize the importance of interdepended and engage in these collective activities to create value. Indeed, recent research is exploring the value of interdependent and complementary offers for ecosystem users (e.g., Borner et al., 2023), thus, firms' strategic decisions within the ecosystem affect the development of these collective processes.

The third hypothesis confirmed, H1c, argued that ecosystem-based strategy positively affected the ecosystem structure innovation process (β =0.231, p= 0.001). Similar to other studies (e.g., Stonig et al., 2022; Thomas et al., 2022), this finding shows that the emergence of an ecosystem is not automatic and requires purposeful actions. In this sense, firms operating in an ecosystem that want to guarantee their role in the ecosystem and succeed also create new processes to build the ecosystem and access its health. Indeed, research shows how an ecosystem leader must deal with issues of modularization and openness to facilitate the access of other actors within the ecosystem (Tee, 2019). Additionally, when competing via ecosystems, firms must decide if they want to pursue the role of an orchestrator or a complementor and establish the appropriate governance mechanisms (Jacobides et al., 2022). Overall, what the results from the structural model suggest is that the strategic decision to guarantee the role can impact the design and structure of an ecosystem.

Overall, the three hypotheses were confirmed, indicating that the ecosystem-based innovation process is a contingency able to explain variations in the innovation processes in ecosystem settings.

8.2 Ecosystem strategy and innovation processes

Beyond investigating the role of ecosystem-based strategy (e.g., centered on sustaining the role), I also investigated the effect of ecosystem strategy, which refers to the firm aiming to create a collective value proposition that is superior and succeeds against rival ecosystems (Gomes et al., 2023).

The first hypothesis explored how firms aiming to compete and succeed with rival ecosystems (the ecosystem strategy) developed new ecosystem-based innovation processes. The hypothesis was confirmed (β = 0.327, p= 0.000) and reflects how to compete with rival ecosystems and ensure a superior value proposition firms build specific ecosystem-based innovation processes. For example, to fill a void in the platform, the orchestrator might assume the role of a complementor and develop a specific type of innovation inside instead of allowing the development of complementors. This is particularly significant when firms are designing the value proposition of the ecosystem. For example, by building a loose value proposition, the ecosystem might attract a higher number of complementors (Malherbe and Tellier, 2022), and this might threaten the quality of the platform (Inue, 2021). However, if the ecosystem has a low level of openness, the firms might need to assume some features of the platform that are not covered by the complementors. Additionally, some critical innovations are central to the focal firm and the decisions that will be developed by the ecosystem firms and complementors are strategic (Murthy and Madhok, 2021). Thus, firms aiming to compete with rival ecosystems, might in turn focus on creating new ecosystem-based innovation processes.

The following hypothesis, H2b, was confirmed and argues that ecosystem strategy positively affects the ecosystem innovation processes ($\beta = 0.358$, $p = 0.000$). This finding illustrates that to compete with rival ecosystems and ensure a superior value proposition, firms need to create innovation processes focused on triggering the engagement of the constellation of actors in an ecosystem to develop superior innovation in relation to rival ecosystems. Similar to previous literature (e.g., Schreieck et al., 2021), these findings show that firms establish new mechanisms to facilitate and trigger the engagement of actors in innovation activities within the ecosystem. Interestingly, due to the interdependence in the ecosystem, the performance of a firm affects the entirety of the ecosystem (Gomes et al., 2023), thus, firms build mechanisms to ensure superior value creation. Findings from previous research show that firms create mechanisms to ensure the quality of the complementors (e.g., Cennamo and Santaló, 2019) and provide unique resources to facilitate innovation development (Ghazawneh and Henfridsson, 2010).

Lastly, the final hypothesis argued that ecosystem strategy positively affects the development of the ecosystem structure innovation process. This hypothesis was confirmed and adds to the literature on ecosystem transformation (e.g., Kolagar et al., 2022) and ecosystem emergence (e.g., Stonig et al., 2022; Thomas et al., 2022). The findings suggest that to compete with rival ecosystems and ensure a superior value proposition, firms need to build ecosystem structure innovation processes to ensure continuous innovation development in the ecosystem and ensure opportunities to improve the ecosystem structure. Indeed, the ecosystem literature has provided initial clues to these dynamics. For example, Kolagar et al. (2022) argue that during the expansion of an ecosystem, a key activity is to continuously evaluate and adapt the ecosystem. This includes for example assessing the ecosystem health over time (Cobben et al., 2023) and exploring how collaborations and complementors are evolving (Holgersson et al., 2022). Overall, to ensure the competitiveness of the ecosystem, firms build processes to create and adapt the ecosystem structure.

Overall, the research's findings show that the ecosystem strategy is a contingency able to explain variations of innovation processes in ecosystems.

9 CONCLUSIONS

The guiding questions of this dissertation were *what are the contingencies that explain variances of innovation processes in ecosystem settings?* and *how do strategies in ecosystems shape innovation processes in ecosystems??*'. The former was answered with a systematic literature review, while the latter was answered with an empirical research based on a survey. Overall, based on a systematic literature review on innovation processes in ecosystem settings and the analysis of the sample of 268 managers involved in ecosystem and innovation management, this research can draw the following conclusions.

First, firms competing via ecosystem face different contingencies that affect variations in innovation processes. More specifically, this research has highlighted (1) ecosystem structure, (2) type of ecosystem, (3) the challenge of collaborating and coordinating autonomous partners, and (4) building and modifying the ecosystem structure are new contingencies brought by the ecosystem that affect the development of new innovation processes. While previous research had focused on exploring how innovation processes are contingent on organizational features limited knowledge is available in understanding the specific contingencies for ecosystem innovation processes.

Second, firms competing via ecosystem build specific processes to address it. While the innovation management literature has taken a contingency view of innovation processes and explored how they assume different features in different contexts, most of the literature has neglected the contingency that explains variations of innovation processes in ecosystem settings. While most research focuses on individual aspects of the innovation process (e.g., search) and recognizes variations of processes according to the role of ecosystem actors, we are still in need of an integrative approach to innovation processes in ecosystem settings. This research has addressed this issue by uncovering a new typology of innovation processes: the ecosystem-based innovation processes, innovation processes within the ecosystem, and ecosystem structure innovation processes.

Third, strategy in the ecosystem is a contingency that explains variation in the innovation processes. The main finding of the systematic review was that firms competing via ecosystem face different contingencies that trigger variations in the innovation process. In this sense, I proceeded to investigate the effect of ecosystem strategies on the innovation processes in ecosystems. The relationships investigated via structural equation modeling have highlighted that both strategies (ecosystem-based strategy and ecosystem strategy) affect the development of new innovation processes. This finding is aligned with the innovation processes literature that discussed the role of strategy in shaping innovation processes.

The findings from this research provide three main contributions to the literature. First, this research contributes to the understanding of innovation processes from the perspective of ecosystem settings. While previous literature recognizes the role of contingencies in explaining variations in the innovation processes, we still had limited insights into the contingencies that cause variations in the innovation processes of the ecosystem. Using a systematic literature review this research has uncovered four contingencies that firms competing in ecosystems face.

Second, this research uncovers the strong relationships between ecosystem strategy and innovation processes. The current scholarship highlights the role of ecosystem strategy for the success of the ecosystem, however, there is still a missing link between ecosystem strategy and ecosystem processes.

Third, this research provides a rich investigation of how the duality of strategy in the ecosystem (ecosystem-based and ecosystem strategy) affects the development of new innovation processes.

For managers dealing with innovation processes in an ecosystem, this research provides useful information that can guide future decision-making. First, the findings show how there are different types of innovation processes that need to be managed in order to create value in ecosystems. Managers should be aware of this complexity and develop conditions to investigate the different types of innovation processes and how the firm is performing specific activities to address them. Second, the different types of innovation processes occur simultaneously, thus, managers should be aware that when choosing a new idea for innovation, the impacts on the different types of innovation processes will be significant. For example, when developing an innovation that requires that complementors learn new technology, managers should also invest in the 'innovation processes within the ecosystem'. Third, the ecosystem does not emerge automatically, this research's findings show the specific processes related to ecosystem creation. Managers should be aware of the costs and difficulties of creating a new ecosystem and allocate resources carefully. Finally, the findings illustrate that managers should be aware that just creating an ecosystem is not enough, firms need to actively create new innovation processes to ensure that value is created and sustained over time.

Notwithstanding the contributions, this research has some limitations that can be addressed by future research. First, the typology of innovation processes was developed using existing research. Future research could employ different methodologies (e.g., case studies) to investigate how innovation processes are organized in innovation settings. Second, the limited sample of 268 responses could be increased by other research focusing on expanding the sample to ensure more validity to the findings. Finally, this research investigated only the relationship between ecosystem strategy and innovation processes. Future research could add moderation and mediation variables to explore more complex relationships.

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APPENDIX

Appendix A – Survey Questionnaire

Ecosystem-based strategy

Minha empresa atua para...		Discordo fortemente 1	2	3	4	Concordo fortemente 5
1	Garantir o seu posicionamento estratégico em seu ecossistema	☐	☐	☐	☐	☐
2	Aumentar os tipos de ofertas de produtos e serviços para o seu ecossistema	☐	☐	☐	☐	☐
3	Evitar que os parceiros assumam a liderança no ecossistema	☐	☐	☐	☐	☐

Ecosystem Strategy

Minha empresa atua na liderança do ecossistema:		Discordo fortemente 1	2	3	4	Concordo fortemente 5
1	Para que o ecossistema ofereça produtos e serviços melhores do que os ecossistemas rivais	☐	☐	☐	☐	☐
2	Para alinhar e gerenciar os parceiros do ecossistema no intuito de oferecer produtos e serviços melhores que os dos ecossistemas rivais	☐	☐	☐	☐	☐

Ecosystem-based innovation processes

Nos processos de inovação de produtos e serviços (busca e seleção de ideias, desenvolvimento e implementação), minha empresa frequentemente…		Discordo fortemente 1	2	3	4	Concordo fortemente 5
1	Modifica os processos de desenvolvimento para permitir que outros parceiros do ecossistema complementem a inovação	☐	☐	☐	☐	☐
2	Utilizam os recursos (ex: financeiros, acesso ao mercado, reputação) da própria empresa para comercializar a solução de terceiros	☐	☐	☐	☐	☐

Innovation Processes Within the Ecosystem

Nos processos de inovação de produtos e serviços (busca e seleção de ideias, desenvolvimento e implementação), minha empresa e os parceiros do ecossistema constantemente…		**Discordo fortemente** 1	2	3	4	**Concordo fortemente** 5
1	Desenvolvem *roadmaps*, ferramentas e outros materiais que permitem que os parceiros do ecossistema reconheçam novas oportunidades ou lacunas na plataforma	☐	☐	☐	☐	☐
2	Desenvolvem metodologias e abordagens (ex: toolkits, espaços de codesenvolvimento, experimentação) para facilitar o processo de desenvolvimento de novos produtos e serviços pelos parceiros do ecossistema	☐	☐	☐	☐	☐
3	Estabelecem estruturas de distribuição e comercialização (ex: *marketplaces*) para facilitar a difusão da inovação dos parceiros do ecossistema	☐	☐	☐	☐	☐

Ecosystem Structure Innovation Processes

A minha empresa e os parceiros do ecossistema...		**Discordo fortemente** 1	2	3	4	**Concordo fortemente** 5
1	Ao modificar o escopo da plataforma (ex:novas funcionalidades, novos serviços), precisam alterar os papéis do ecossistema (ex:novos tipos de parceiros para desempenhar essas novas funcionalidades)	☐	☐	☐	☐	☐
2	Produzem inovações para gerar novas capacidades, tecnologias, papéis únicos no intuíto de ofertar uma solução superior para concorrer com ecossistemas rivais	☐	☐	☐	☐	☐