Uncovering the conceptual boundaries of the ecosystems: Origins, evolution and future directions

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The divergent definitions and inconsistent features of the popular ecosystem concept have confused practitioners and academics, and has caused ambiguity about the relationships between the "business ecosystem" and "innovation ecosystem". The purpose of this paper is to provide a deeper understanding about the ecosystem's conceptual boundaries. Using a systematic literature review as the foundation, we identified 12 defining features that define and delineate the ecosystem concept, and which are classified into three distinct but interactive dimensions: *1)* the *roles* features delineate the membership and relationships among actors; *2)* the *structures* features illuminate the condition of power distribution and the sphere of the power influence; and *3)* the *processes* features explicate where and how the whole ecosystem evolves through the lifecycle. Further, we propose that innovation ecosystems can be considered a subset of business ecosystems, depending on a time-based perspective. Our study contributes to a clearer understanding of the ecosystem concept, which reduces conceptual ambiguity and enables rigorous theory development. For practitioners, our results provide insights into strategies to better enter, develop and benefit from business and innovation ecosystems.

1. Introduction

The *ecosystem* concept is currently raising enduring enthusiasm among academics and practitioners alike, since it promises economic and social wealth (Shang & Shi, 2013; Lu et al., 2014, Overholm, 2015; Guo et al., 2016, Hedman & Henningsson, 2015). For instance, through innovation and business ecosystems, large enterprises can sustain their market positions (Hannah et al., 2016) and create keystone effects (Kang & Downing, 2015); new participants in ecosystems are likely to obtain more entrepreneurial opportunities than outsiders (Overholm, 2015; Matopoulos et al., 2012). Furthermore, an established ecosystem can produce the social effects, such as promoting public services (Peltola et al., 2016; Christensen et al., 2014) and resolving global human diseases (Li, J F & Garnsey, 2014). As a partial metaphor from biology, the ecosystem refers to a set of "companies that co-evolve capabilities around a new innovation: they work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovation" (Moore, 1993: 76).

However, current practitioners face challenges to co-create and co-capture value from these ecosystems. First, it appears hard to develop and transit their ecosystems through stages of birth, expansion to leadership (Letaifa, 2014). For ecosystem's outsiders, especially the new ventures, it is difficult to enter and participate the ecosystems (Perrone et al., 2010).

To address these challenges, literature has applied the ecosystem concepts to study various industries and topics with different purposes (de Vasconcelos Gomes et al., 2016, Li, J F & Garnsey, 2014). Since the original introduction (Moore, 1993; Iansiti & Levien, 2004b; Adner, 2006), researchers have given conflictive opinions on relationships between the two

original concepts: "business ecosystem" and "innovation ecosystem", which are widely employed by the other scholars. As a result, the competing and ambiguous findings have been generated by the different definitions and inconsistent features, which have created ambiguity for managers and have impaired the conceptual rigor and clarity (Oh et al., 2016). Therefore, to address managerial challenges to leverage ecosystems, we first need to create clarity about the ecosystem's nature and conceptual boundaries.

This study responses to the recent rise of appeals to clarify the ecosystem conceptual boundaries (e.g., Autio & Thomas, 2014; Adner, 2016; Oh et al., 2016) and addresses two sequential research questions: *1) how to conceptually understand an ecosystem? 2) what are the conceptual boundaries of the business and innovation ecosystem?*

To determine the conceptual boundaries, we followed van Oosterhout (2005: 677), who distinguished two ways to define concepts in the management and organization study. The first way is the *extensional* definition, which means "pointing out and describing the set of real-life phenomena the concept refers to". The second way van Oosterhout (2005) distinguishes is the *intensional* definition, which is "specifying the conjunction of general attributes that make up the concept". Given our two research questions, we examine the ecosystems' conceptual boundaries through the latter lens: the "content boundary" relates to the *intensional* definition—as the demarcation that discriminates it from other relevant concepts (e.g., networks, alliances or supply chains).

We applied a systematic literature review to shed light on the knowledge from the origins and evolution history to the current status (Tranfield et al., 2003). Based on 128 papers dispersed into various topics, we executed a comprehensive content analysis to consolidate our results.

The findings clarify the conceptual boundaries of ecosystems. The "content boundary" suggests that an ecosystem should be understood with three distinct and interactive dimensions: the *roles*, *structures* and *processes*. The *roles* dimension characterizes the participants' membership and relationships (respectively telling "who is who" and "who we are"); the *structures* dimension describes the ecosystem's power distribution and sphere of power influence (telling "how we are organized"); the *processes* dimension portrays the ecosystem's lifecycle (telling "where we go"). Further, our review indicates that the business and innovation ecosystem are different at first sight but can be converted into one when taking a lifecycle perspective. Both are procedural phenomena ranging from value propositions, value co-creation, value sharing to final value co-capture.

Our systematic literature review adds to the ecosystem literature and knowledge for the practitioners as follows. First, the multifaceted conceptualization clearly defines and delineates business and innovation ecosystems. This offers scholars to better clarify the boundaries of their unit of analysis and improves academic rigor. It also provides a solid basis for developing metrics to measure ecosystem health and performance. Second, for practitioners, our study offers insights into factors that determine effective strategies to start, develop and maintain ecosystems. Additionally, we propose that new ventures that who identify and intend to participate in an certain ecosystem should proactively take the temporal factors and industry qualities into account.

2 Research method

2.1 Description of the sample

To answer the two research questions, we conducted a systematic literature review following the suggestions by Tranfield et al. (2003) and Thorpe et al. (2005). Figure 1 illustrated the stages of the review. We selected three databases including *Web of Science*, *Scopus* and *Science direct* only for the peer-reviewed papers and reviews. We then used the research strings of "innovate* ecosystem*" and "business ecosystem*" as well as their synonymies to collect the initial data.[1] After removing duplicates, the results came to a selection of 3498 articles.

Following the guidelines by Becheikh et al. (2006), the identified articles were subjected to double screenings to narrow down the data. We applied six exclusion criteria to refine the data: *1)* title, abstract or keywords are not relevant for this study; *2)* ecosystem service or service ecosystem (topic irrelevance); *3)* industrial ecosystem (topic irrelevance), *4)* journal (with low impact factors ($<$ 0.200)); *5)* main findings are not relevant for this study and *6)* the paper does not cite one of the seminal works.[2] In this way, only 193 studies remained. After complete reading, 77 papers were removed from the dataset for topic irrelevance or with limited theoretical contributions (Mol et al., 2015).

Besides the four seminal books, we added two inclusion criteria: *a)* important for theory construction and *b)* papers that were cited frequently (cf., Crossan & Apaydin, 2010). We added another eight papers which were found highly relevant, but were not acquired in the initial searching results. These eight

[1]Search string: innovat* ecosystem* *OR* business ecosystem* *OR* (start-up* *OR* entrepreneu* *OR* software* *OR* platform* *OR* digital* *OR* supply* *OR* universit* *OR* industr* *OR* policy* *OR* knowledg* *AND* ecosystem*)

[2]Eight papers: Moore (1993, 1998, 2006); Iansiti and Levien (2004b); Iansiti and Richards (2006); Adner (2006); Adner and Kapoor (2010a, 2010b). Four books: Moore (1996); Iansiti and Levien (2002, 2004a); Adner (2012)

papers were classified into two domains: four papers talking about "innovation orchestration" (Dhanaraj & Parkhe, 2006, Nambisan & Sawhney, 2011, Ritala et al., 2009; Ritala & Hurmelinna-Laukkanen, 2009) and four papers explicating "boundary problem" (Post et al., 2007; Gulati et al., 2012; Halinen & Törnroos, 2005; Santos & Eisenhardt, 2005). We finalized our sample with 128 articles published from 1993-2016.

2.2 Sample description

Table 1 shows the distribution of journals in our sample, listed over four time periods. It shows since the original article on "business ecosystem" was published in 1993, for nearly two decades this concept had been underexplored (32 papers) in contrasts to recent five years (92 papers). The total number of papers published in twelve journals over two times occupied 41.9 percent of all the data. Such topic continuity, we think, laid a solid foundation for the following theory development. The other papers were dispersed over another 63 academic journals whose preferences were mainly about system management (23), technological innovation (19) and entrepreneurship (21). We contended the topic diversity of publications indicated the concept had been discussed widely and provided abundant raw materials for our research questions.

Table 1. Distribution of journal and number per interval (n=124)

Journals (not include 4 books)	Impact factors (2016)	Periods				
		1993-2001	2002-2006	2007-2011	2012-2016	Total
Strategic Management Journal	3.341			3	4	7
Technological Forecasting and Social Change	2.058				7	7
Technology Innovation Management Review	-			1	6	7
Technovation	2.526			2	3	5
Advances in Strategic Management	0.682				4	4
Journal of Systems and Software	1.352				4	4
Harvard Business Review	1.574	1	2			3
International Journal of Innovation and Technology Management	0.867				3	3
International Journal of Technology Management	0.625				3	3
Journal of Product Innovation Management	1.696				3	3
R&D Management	1.190			2	1	3
Telecommunications Policy	1.411			1	2	3
63 other journals		1	5	14	52	72
Total		2	7	23	92	124

Table 2. Distribution of research methods per interval (n=124)

Research methods	Periods				
	1993-2001	2002-2006	2007-2011	2012-2016	Total
Case study			6	39	45
Theoretical-conceptual analysis	2	6	11	16	35
Quantitative study (Secondary data)			3	7	10
Review		1		9	10
Simulation			2	5	7
Surveys only				5	5
Interviews only				3	3
Modeling				2	2
Experimental study				1	1
Action research				1	1
Others (mixed methods)			1	4	5

In Table 2, we find that the studies applied a variety of methodologies. Owing to the complex nature of the ecosystem (Mantovani & Ruiz-Aliseda, 2016, Pierce, 2009) and its diversified theoretical understandings (Peltoniemi, 2006; Weber & Hine, 2015), researchers inclined to choose qualitative approaches. Forty-five (36.3 percent) case studies, thirty-five (28.2 percent) theoretical-conceptual analyses and ten (nearly eight percent) reviews occupied a large share of the papers. A small number of researchers only opted single method such as interviews or surveys (three and five articles respectively). This shows that the research related to the ecosystem concept had not yet been merged.

In addition, as to the fraction of quantitative studies, we checked that researchers examined ecosystems with the secondary panel data or simulation tools (ten and seven papers respectively). Besides, the modeling

method was also found. Mantovani and Ruiz-Aliseda (2016) exhibited a game model and Zhang, W et al. (2014) set a mathematical revenue model in their analyses. One experimental study evaluated the effectiveness of three visualization methods to measure the business ecosystems' performance (Basole et al., 2016). One action research described how the innovation ecosystem emerged (Spena et al., 2016). The remaining five papers combined the techniques mentioned above (Ansari et al., 2015, Borgh et al., 2012, Lu et al., 2014, Tiwana, 2015, Weiss & Gangadharan, 2010). It was clear that the empirical studies for ecosystem' health and performance were relatively insufficient. Most empirical studies were mainly situated in the last period (2012-2016), which implies a trend that a growing number of studies attempt to measure the ecosystem's performance.

In Table 3, we made further efforts to analyze the industry sectors. We employed *The Global Industry Classification Standard* [3] to categorize 72 papers into ten sectors. According to the Table 3, we saw nearly 60 percent of 72 papers focusing on information technology industries. This group includes the sub-industries such as software, IT hardware and affiliated services. This indicates that the ecosystem phenomena has been particularly researched in high volatile environments, while the ecosystem in low-competition industries were under-studied.

Table 3. Distribution of industry sectors per interval (n=72)

Industry sectors	Periods				Total
	1993 - 2001	2002 - 2006	2007 - 2011	2012 - 2016	
Information technology		1	8	34	43
Health care				8	8
Industrials			1	5	6
Tele-communication			3	3	6
Consumer discretionary			1	4	5
Energy				3	3
Consumer staples				1	1
Financials				1	1

3 Content analysis

3.1 Origins: three streams of seminal works

3.1.1 Moore's business ecosystem Based on the observation that the species connection and energy cycling in the nature made the "ecosystem" being an analogy of what happened in the business environment, Moore (1993: 76) proposed that the business ecosystem refers to an "intentional community of economic actors whose individual business activities share in some large measure the fate of the whole community". Moore described how the big firms tactically constructed their ecosystems within four sequential lifecycle stages: birth, expansion, leadership and self-renewal/death. In such process, a successful business ecosystem relied on: *1)* loosely controlled members; *2)* platforms for knowledge sharing; *3)* aligning members with joint visions; and *4)* keeping a semi-stable collaboration structure.

In his 1996 thesis, Moore further specified that a business ecosystem consists of three tiers: the core firms, the extended network and the peripheral actors, as drawn in the Figure 2. Thereafter, he continued the discussion about the four lifecycle stages: *1)* the importance of value proposition in the embryonic stage; *2)* the importance of value co-creation during the second stage; *3)* the importance of new value propositions in the third stage; and *4)* the importance of new value co-creation for renewal in the final stage.

Moore's 1998 paper went beyond to discuss the leading firms' ecosystem-level orchestration capabilities. As a new form of interfirm collaboration, ecosystems are critical for leaders to find complements, build adaptability and as a result lead the whole co-evolution.

In his final seminal work, Moore (2006) advanced the understanding about business ecosystems' social potentials. For example, if a set of firms desired to address a major global problem, such as malaria, then a business ecosystem was a superior approach.

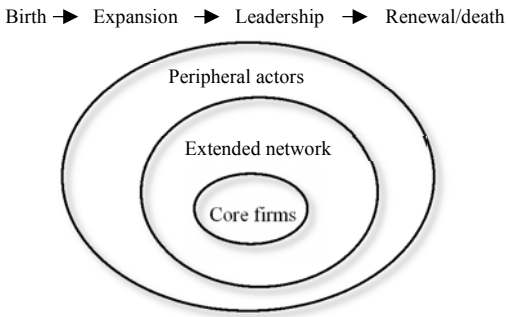

Figure 2. The model of Moore's business ecosystem

3.1.2 Iansiti and Levien's business ecosystem During the same period, three works by Iansiti and Levien (2002, 2004a, 2004b) plus one work by Iansiti and Richards (2006) revisited the business ecosystem concept.

Iansiti and Levien (2002, 2004a, 2004b) [4] analyzed the ecosystem's structural health with three indicators: *1)* robustness—the ability to face disruptions from outside environment; *2)* productivity—the ability to deliver continuous value to the customers; and *3)*

[3] *https://en.wikipedia.org/wiki/Global_Industry_Classification_Standard*

[4] In fact, the main points discussed in two books (2002 and 2004a) have been refined in the 2004b paper.

diversity—the ability to provide a variety of values to customers. They distinguished three main ecosystem fundamental roles: the dominators, keystones (hubs) and niche players. Accordingly, there were corresponding ecosystem strategies: the keystone strategies—creating and sharing value with participants; the dominator strategies—extracting maximal value; and the niche player strategies—being specialization. We summarized these aspects in a model, which is depicted in the Figure 3. To make their arguments more tangible, Iansiti and Richards (2006) provided the information and technology (IT) ecosystem as an real-world example. Such ecosystem had two critical and distinct roles: application providers (niche players) and platform providers (keystones and hubs) and its health could be demonstrated by the productivity, robustness indicators, the rapid innovation, diversified platforms and innovative business models.

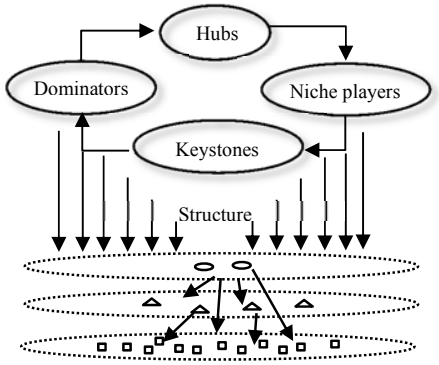

Figure 3. The model of Iansiti and Levien's business ecosystem

3.1.3 Adner's innovation ecosystem Adner who initially coined the "innovation ecosystem" (2006, 2012) regarded it as the sum of technology interdependence among the focal firms, upstream components, downstream complementors and end-users (See Figure 4). Particularly, Adner asserts that an innovation ecosystem presents a set of risks to the focal firms: *1)* the initiative risks—the challenges of delivering the value at the right time by the focal firms; *2)* the co-innovation risks—the uncertainties of coordinating with complementary innovators; and *3)* the integration risks—the final adoptions by the end-users. Taking these risks into account, the innovation ecosystem emphasizes time delays for value creation: whether the focal firms are ready to initiate an innovation; whether their component partners will succeed on time; whether the complementors and end-users are prepared to adopt the new innovations.

To be tangible, Adner and Kapoor (2010a, 2010b) took two examples to explore the structural risks caused by actors' interdependence. They concluded that the temporal factors (technology evolution) and location (technology input and output) largely restricted the focal firms', and consequently the whole ecosystem's, performance.

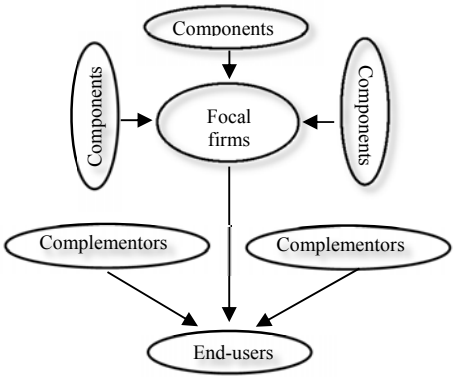

Figure 4. The model of Adner's innovation ecosystem

3.1.4 Summary Although Moore's, and Iansiti and Levien's business ecosystem concepts seem to differ from each other and moreover from Adners' innovation ecosystem concept at first sight, we observe similarities and complementarities. First, knowing what an ecosystem is begins with knowing who the involved actors are. Moore generally classified all actors into three tiers: core firms, extended network and peripheral actors. However, Adner, Iansiti and Levien respectively clarified the core actors into four main roles. Thus, where Moore analyzed the problem about "whose ecosystem", Adner, Iansiti and Levien specified this by differentiating between "who is who" (Isckia, 2009).

Next, we need to know how these actors are organized. Moore, Iansiti and Levien were aware of the pivotal position of the platform providers in business ecosystems. On the platform, providers maintain their leadership by orchestrating participants while non-focal roles align themselves. For the innovation ecosystem, the roles are connected by a coherent set of interdependent technologies.

Third, the business ecosystem and innovation ecosystem differ in time-perspective. While Moore, and Iansiti and Levien considered the ecosystem from a lifecycle perspective with a focus on value capturing and survival, Adner paid more attention to the short-term strategies about how to resolve technological uncertainties and achieve value co-creation. Overall, we conclude that the innovation ecosystem conceptually can be seen as a subset of the business ecosystem, since value co-creation (in the innovation ecosystem) precedes the final value capture (in the business ecosystem).

3.2 The evolution of ecosystem concepts: contents

The analysis of the papers from the literature review concerns the *intentional* definition of the ecosystem concept (Van Oosterhout, 2005). Just as showed in table 5, it could be concluded that the ecosystem

concept is multifaceted and rich in its nature. From 20 studies we directly derived 33 characterizations which define the ecosystem concepts *intentionally* (van Oosterhout, 2005).[5] Given that some of them have synonymy relationships, we synthesize them into 12 main features, which can be clustered in three main dimensions (see Table 5): *roles*, *structures* and *processes*. The *roles* dimension relates to participants' membership ("who is who") and relationships ("who we are"). The *structures* dimension pertains to how the participants are organized. The *processes* dimension centers on the ecosystem's lifecycle ("where we go").

Table 5. The overview of ecosystem's main features

Author(s)	Characterizations (33)	Synthesis	Dimensions (3)	Main features (12)
Peltoniemi (2006)	Interconnectedness; coopetition; co-evolution; self-organization; emergence		Roles	Focal roles
Basole (2009)	Self-adaption; co-evolution			
Le and Tarafdar (2009)	Value co-creation; keystone effects; self-organization			Co-specialization
Borgh et al. (2012)	Closeness; shared fate			
Sloane and O'Reilly (2013)	Coopetition; co-evolution; hierarchical relationships			Co-opetition
Mäkinen and Dedehayir (2013)	Modular structure; co-specialization			
Nambisan and Baron (2013)	Interdependency; shared goals; co-evolution			Pooled interdependence
Letaifa (2014)	Interdependence; coopetition; shared vision; value creation and capture; ecosystem leadership			
Autio and Thomas (2014)	Focal firm; value co-creation			Loosely-coupled structure
Weber and Hine (2015)	Self-adaption; flexible role; technological capabilities of actors			
Russell et al. (2015)	Shared vision; network orchestration; alignment		Structures	Hierarchical structure
Oksanen and Hautamäki (2015)	Continuous innovation; value co-creation			
Bosch-Sijtsema and Bosch (2015)	Platform providers; co-evolution; interdependence			Modularity
Basole et al. (2015b)	Value co-creation			
Hedman & Henningsson (2015)	loosely connected multi-actors; platforms; co-evolution; mutual adaption			System-level business model
Hannah et al. (2016)	Coopetition; co-specialization; interdependence; continuous alignment			Shared vision
Shaw and Allen (2016)	Value process; orchestrated business model			
Guo et al. (2016)	Loosely connected multi-actors, platforms; co-evolution		Processes	Co-evolution process
Pulkka et al. (2016)	Specialization; complementariness; co-evolution			Value process
Adner (2016)	Alignment process; value process; focal firm; interdependence			Orchestration-alignment process

3.2.1 The conceptual boundary of roles The starting point in understanding the ecosystem would be to conceive of it as a network of various roles that enacted by actors (Moore, 2006; Iansiti & Levien, 2004b; Adner, 2006). Preliminarily, at the ecosystem's inception, all actors who are involved in value activities achieve its membership. When the membership framework is consolidated, it guides to produce mutual relationships (Gulati et al., 2012). Therefore, the membership tells "who is who" while the relationships tell "who we are".

There are miscellaneous investigations to term the ecosystem membership. For example, Adomavicius et al. (2007) argue that a technology ecosystem includes the component role, application role and support/infrastructure role. Rong et al. (2011) ascertain three functional roles in the ecosystem: the initiator role, specialist role and adopter role. In a recent review, scholars revel that the leadership role, direct value creation role, value creation support role and entrepreneurial role are identifiable in the ecosystem genesis (Dedehayir et al., 2016).

[5] Except the seminal works, we observed another 20 papers by explicitly announcing the conjunction of general attributes that made up the ecosystem concept (e.g., "an ecosystem is characterized/featured…").

Considering this review does not seek to examine all different typologies, we nevertheless have observed that *1)* scholars exercise greater focus on core roles as opposed to peripherals (Pulkka et al., 2016); that *2)* they preferably define or identify roles based on stakeholder theory (Peltola et al., 2016; Lu et al., 2014), role theory (Bosch-Sijtsema & Bosch, 2015; Chou & Huang, 2012), biology population theory (Weber & Hine, 2015; Shaw & Allen, 2016) and even institutional theory (Muegge, 2011); and that *3)* owing to the functions of focal roles (e.g., ensuring ecosystem stability, forging partnerships, supervising platforms and redeploying resources (Kang & Downing, 2015)), the leader role is an indispensable puzzle. Such *focal role* and its proxies— focal firm (e.g., Gueguen, Gael, 2009), hubs (e.g., Nambisan & Baron, 2013); orchestrator (e.g., Gastaldi & Corso, 2016, Korpela et al., 2013); platform provider (e.g., Ceccagnoli et al., 2011, West & Wood, 2013, Zhong & Nieminen, 2015); keystone (e.g., Iansiti & Levien, 2004a, Kang & Downing, 2015) serve a defining ecosystem feature.

As to the picture of the interrelationships, we delineate them in terms of *co-opetition*, *co-specialization* and *pooled interdependence*. Participants cooperate to pursue common interests and simultaneously compete for capturing value. The *coopetition*, especially the multilateral coopetition, is of paramount importance in the building stage (Ritala et al., 2013; Gueguen, Gaël & Isckia, 2011; Gueguen, Gael, 2009). However, the competition and cooperation among actors might not happen at the same time. The intertemporal coopetition matters when new entrants are forced to closely collaborate with the incumbents to get the ecosystem membership and afterwards compete for the markets together (Zahra & Nambisan, 2011; Ansari et al., 2015). Besides, the intensity of coopetition increases at a decreasing rate at maturity stage, which should be managed properly by focal roles (Basole et al., 2015a; Davis, 2013).

Participants are *co-specialized* based on core knowledge, resources and capabilities which leads to the synergic complementariness among actors (Pulkka et al., 2016; Hienerth et al., 2014). When the focal roles desire to improve the efficiency of value co-creation, Zhang, W et al. (2014) suggest that they should choose partners with complementary resources. The co-specialization also explicates the shared fate. For example, in the entrepreneurial context, the breeder role has strong technological capabilities but is rather weak in marketing and relational capabilities, where the feeder role and the niche role are excel (Ansari et al., 2015).

Participants are *pooled interdependent*. That is, the value of one actor's product depends on the availability of others' that collectively comprise a whole solution. Given a myriad of vertical, horizontal and diagonal linkages, the interdependence situation in the ecosystem is moderate (Kapoor & Lee, 2013) in order to avoid excessive embeddedness (Ketchen et al., 2014, Sloane & O'Reilly, 2013). Except the technical interdependence (Adner & Kapoor, 2010b), the participants are socially interdependent grounded on mutual trust and commitment (Pulkka et al., 2016).

3.2.2 The conceptual boundary of structures The *structures* dimension describes how the power is distributed among participants as well as the sphere of influence (Manikas, 2016, Manikas & Hansen, 2013). The portfolio of the knowledge, resources, capabilities and routines gives rise to the role-based power (Velu, 2015), which helps the focal firms and even the whole ecosystem seek for leadership and control (Autio & Thomas, 2014; Gawer & Cusumano, 2014). The central argument presents the understanding: "how we are organized". The condition of the power distribution is featured by the *loosely-coupled structure*, *hierarchical structure* and *modularity*. The condition of power sphere is featured by the *system-level business model*.

Participants are *loosely coupled* around the focal roles whose primary job is to balance distinctiveness and responsiveness of the ecosystem's participants (Brusoni & Prencipe, 2013). On the one hand, the "distinctive linkage" allows members to pursue individual agendas and emphasizes the self-adaption and self-organization (Peltoniemi, 2006; Basole, 2009; Shaw & Allen, 2016). While on the other hand, the "responsive linkage" concentrates on collective manners to address complex problems which typically consists of a variety of elements, high level interdependence among these elements and high unpredictability of the interdependence. Therefore, the loosely coupled structures need the interventions from the focal actors (Brusoni & Prencipe, 2013).

Due to the technological relatedness and heterogeneity, participants are layered in *resource-based hierarchies* (see the models in Adomavicius et al., 2007; Sloane & O'Reilly, 2013; Guo & Bouwman, 2016). In an ecosystem, the upper tiers enjoy more decision making rights and bear more responsibility than lower tiers (Bosch-Sijtsema & Bosch, 2015; Song, 2016). Further, flatter structures often involve multilateral negotiation efforts and makes it harder to arrive at community-level decisions (Gulati et al., 2012). Therefore, a moderate hierarchy reduces managerial complexities and enables task coordination (Rong et al., 2013b).

The ecosystem "provides value to end-user by integrating functionally interdependent sub-systems" (Mäkinen & Dedehayir, 2013: 4). As a deliberate design for the reduction of system complexity, creation of variety and the need for balancing standardization (Moore, 2006; Muegge, 2013), *modularity* refers to the actors can be separated and recombined (Weiss & Gangadharan, 2010; Le & Tarafdar, 2009). Compared to the monolithic structure, the open modular structure would generate excessive autonomy (Isckia, 2009; Wallin, 2012). Hence, input control mechanisms such as enforcing entry barriers, would guarantee the

modules' interoperability (Tiwana, 2015; Koch & Kerschbaum, 2014; Axelsson & Skoglund, 2016).

Participants are locked into *boundary-spanning business models*. The argument from Li, J F & Garnsey (2014: 770) appreciates its function on connecting players—"evidence on the firm's transactions and business model identifies the ecosystem boundary". So, in order to steer the ecosystem, the focal role must accommodate organization-level business models of the ecosystem's members (Gawer & Cusumano, 2014; Kim, 2016), deliberately redesign the hybrid business model to keep long-term viability (Rong et al., 2015a; Wallin, 2012), and if necessary, deter mismatched individual business models (Borgh et al., 2012). Whereas, in aim of securing individual positions, the non-focal participants must dynamically transform their business models (Hellström et al., 2015).

3.2.3 The conceptual boundary of processes Ecosystems are changing entities and should be viewed as procedural systems during the lifecycle (Borgh et al., 2012; Battistella et al., 2013). The central argument highlights: "where we go". Thereby, the *shared vision* is the orientation while the *value process*, *the co-evolution process* and *the continuous orchestration-alignment process* are necessities.

The *shared vision* serves a motivational mechanism for all actors. The philosophies behind a shared ecosystem vision are compatibility with the agreed social norms and regulations, participants' in-depth understanding of the nature and agenda of the ecosystem, and mutual awareness of a collective identity (Autio & Thomas, 2014; Pellikka & Ali-Vehmas, 2016).

The *co-evolution process* describes "reciprocal relations where all participants benefit from the interaction and change in the direction to better compatibility" (Peltoniemi, 2006: 12). Understanding the co-evolution requires an examination of participants' interdependences. The technology embeddedness benefits technology extension, substitution and revolution (Adner & Kapoor, 2010a). As a result, all participants' technological capabilities are co-evolved (Li, Y-R, 2009). This S-curved trajectory informs the performance discrepancies in different stages (Mäkinen & Dedehayir, 2013). Aside from it, co-evolution also refers to dynamic adaptions between ecosystem strategies and external environment (Pellinen et al., 2012; Pulkka et al., 2016). In such adaptive process, the ecosystem has experienced multiple roles transformations and structural reconfigurations to arrive a robust situation (Lu et al., 2014; Annanperä et al., 2015).

Throughout the lifecycle, the ecosystem experiences iterative value processes ranging from value proposition, value co-creation, value sharing to value co-capture (Basole et al., 2015a; Lu et al., 2014; Attour & Barbaroux, 2016). From here, the value proposition acts as the blueprint (Adner, 2016; Khalil et al., 2011). To materialize the proposition, the joint value co-creation focuses on exploiting the existed and exploring the potential complementarities (Le & Tarafdar, 2009). However, "*co-creation does not automatically lead to co-capturing*" (Clarysse et al., 2014: 1174). So, the value sharing schemes are adopted, which make up the negatives of asymmetry capabilities (Zhang, J & Liang, 2011; Guo et al., 2016). Finally, in addition to the company level, the value capture also happens at the ecosystem-level to measure the collectively-extracted "revenues" (Peltola et al., 2016).

The value process is circulative, non-linear and shapes the ecosystem (Dedehayir & Seppänen, 2015). In the creation stage, the ecosystem is featured by low value co-creation, value sharing and value co-capture. In the expansion stage, the value proposition is required to be realigned and the level of value co-creation, value sharing and value co-capture are higher than before. Next, in the leadership stage, the value proposition again needs to be realigned again when the level of value co-creation, value sharing, value co-capture climbs the highest. In last stage, in spite of the value proposition being revised, the level of value co-creation, value sharing and value co-capture are going down (adapted from Letaifa, 2014: 288).

Often intertwined with foregoing processes, the *orchestration and alignment processes* similarly nurtures the ecosystem (Isckia & Lescop, 2015). The growing complexity in the ecosystem requires non-stop alignment and realignment. Thus, on the "soft side", the alignment process focuses on the convergence of individual incentives (Li, J F & Garnsey, 2013). While on the "hard side", niche actors have to align their complementary resources with goals set by focal roles (Moore, 1993, Siripitakchai et al., 2015). Beyond these, such processes could be perceived as a self-regulatory processes (Nambisan & Baron, 2013). Participants regulate themselves to achieve double goals: keeping aligned with ecosystems as well as retaining flexibility.

Accordingly, the orchestration processes intentionally facilitate the value processes and co-evolution processes (Ritala et al., 2013; Dhanaraj & Parkhe, 2006). In ecosystems, the orchestrators sense and mobilize the heterogeneous knowledge (Spena et al., 2016, Velu, 2015; Leten et al., 2013), redeploy the complementary resources (Hannah et al., 2016), synchronize the partnerships and actions (Davis, 2013; Korpela et al., 2013). Therefore, "the orchestration process is entrepreneurial in its nature" (Wallin, 2012: 103).

3.2.4 The interactions between roles, structures and processes Thus far, we have described the three dimensions on main features that a general ecosystem exhibits. There are, in addition, interactions among them.

The processes often dominate the roles because of its grip on ecosystem roles. There is a process of roles transformations during the whole lifecycle (Dedehayir et al., 2016; Zahra & Nambisan, 2012). For example,

in the case of electric vehicle industry, Lu et al. (2014) find that the central government plays the dominator role during the initiating stage, it then becomes the normal participant in the next emerging stage. After that, its role is replaced by the local government and manufacturers, while in last converging stage, the central government returns to dominate the ecosystem.

Next, the openness of the membership experiences a U-shaped route across the whole lifecycle (Gulati et al., 2012; Pulkka et al., 2016). Namely, in the early stage, the ecosystem membership is open to everyone (Rohrbeck et al., 2009). In the expansion stage, it turns to semi-permeable when requirements are set for entering. In the leadership stage, membership is closed since entering is based on selections. In the death stage, membership should be open again to reshape the ecosystem (adapted from Bosch-Sijtsema & Bosch, 2015: 964).

In addition, the processes are likely to dominate the structures, particularly in extreme occasions. For example, when the ecosystem is confronted with a collective inability to overcome the emerging challenges of a new technology, co-evolution calls for tightly coupled structures which is characterized by homogeneous actions across heterogeneous firms (Adner & Kapoor, 2010a). Despite, the "tight coupling is a temporary feature of ecosystems" (Brusoni & Prencipe, 2013: 184). In the renewal stage, the levels of value co-creation, sharing and co-capture declines to the bottom where the ecosystem structures face options to either recombining modules to create opportunities, or to overturn the system-level business model (Rong et al., 2011).

In sum, we argue that twelve features are complementary, co-evolutionary and consequently construct the ecosystem's "content boundary". Therefore, a general ecosystem is supposed to be pictured by the Figure 6.

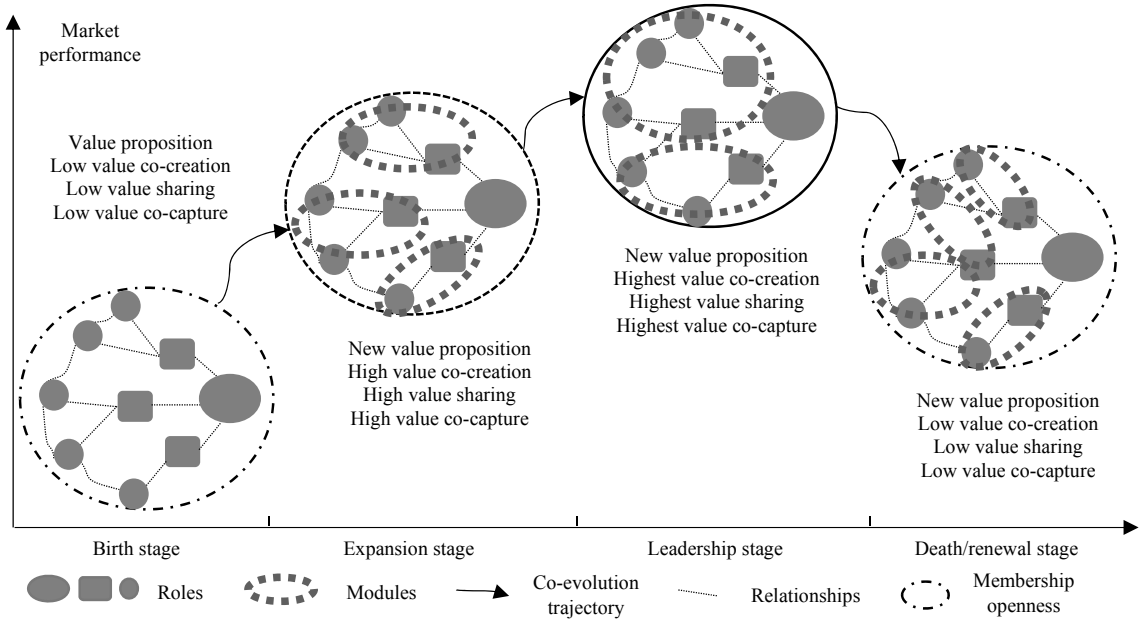

Figure 6. The visualization model of a general ecosystem

4. Discussion

In this study, we seek to answer the research question on how to define the conceptual boundaries of the innovation and business ecosystem. Based on a systematic literature review we identified twelve features that describe and delineate the business and innovation ecosystem. Further, this review reaches a moderated conclusion relating to the relationships between two original concepts: the business ecosystem and the innovation ecosystem. In a short-term and snapshot view, the business ecosystem (value co-capture) and innovation ecosystem (value co-creation) are different if only allowing for the respective outputs. While in a lifecycle perspective, the innovation ecosystem (value co-creation) precedes the business ecosystem (value co-capture). Both could be congregated into the value process ranging from value proposition, value co-creation, value sharing to value co-capture. Therefore, in ecosystem studies, researchers should explicitly set their analysis level or focus in advance (Adomavicius et al., 2007; Valkokari, 2015).

4.1 Theoretical implications

Our main theoretical contribution is focused on how to understand an ecosystem itself, namely the conceptual boundaries. In response to the calls for pursuing greater conceptual rigor and clarity of the ecosystem concept (Adner, 2016; de Vasconcelos Gomes et al., 2016; Autio & Thomas, 2014; Oh et al., 2016), this review has outlined 12 main defining features that define and delineate business and innovation ecosystems.

Particularly, these twelve features enables academics to clearly determine their units of analysis. In order to recognize the participants in a studied ecosystem, the first step is to pinpoint the focal actors. Depending on these focal actors, researchers could find out *1)* the other roles (measuring the sense of identification); *2)* the system-level business model (measuring the sense of collective); *3)* the shared vision or value proposition (measuring the sense of purpose). The clearer and stronger the identification, the collective and the purpose as the informants report, the more possible they belong to the ecosystem. Therefore, the ecosystem's insiders and outsiders are clearly demarcated, which lays the foundation to the empirical inquiries.

4.2 Practical implications

First, managers try hard to evolve their ecosystems after the birth stage (Rong et al., 2015b; Dedehayir & Seppänen, 2015). An adoptable strategy would be to reconfigure the actors (Adner, 2012), since failures follow with a deficient coordination of the strategic actors over which the initiators have no control (Lu et al., 2014; Peltola et al., 2016). Alternatively, one could resort to recraft the system-level business model, yet this might be effective without a consideration of the ecosystems' lifecycle (Hellström et al., 2015). These revel that the ecosystem transition (or evolution) is not merely the results of managing the stakeholders or the internal structure (Rong et al., 2015a).

Based on our findings, large firms who intend to transit their ecosystems are suggested to *1)* re-open up or restrict the membership in different stages (*roles*); *2)* recombine the modules, temporarily adopt the tightly-coupled structure or adjust the system-level business models (*structures*); *3)* revise the shared vision or re-align the value propositions (*processes*); and *4)* continually take the interactive influences between the *roles*, *structures* and *processes* in consideration to prevent falling into the "death" stage by renewing the ecosystem rapidly.

Second, our results provide guidelines for new entrants that seek to join an existing ecosystem. Especially the new ventures which are limited by scarce complementary resources and ecosystem experience, could start with *1)* identifying the focal roles; *2)* fully assessing the ecosystem structural risks; *3)* watching for the industry properties and the social environment they embedded in. Meanwhile, the entry and exit time also matter. At the birth stage, joint with focal firm(s) they could acquire the "first mover advantage" (Rong et al., 2013a; Adner & Kapoor, 2010b). Comparably, if they join at the leadership stage (high value co-creation and co-capture), a multiple of value processes enable them to grow up in a high speed.

4.3 Future directions

First, although the "internal conceptual boundaries" are important for the answer: what does the ecosystem mean? However, as we observed in the literature, the Michelin's PAX run-flat tire supply ecosystem is transformed from the established strategic supply chains (Adner, 2016). Under the "*New Normal*" economy, the enduring coupling between the strategic networks in emerging and traditional industries has generated new ecosystem phenomena, such as the mobile payment ecosystem (Guo et al., 2016; Hedman & Henningsson, 2015; Suh & Sohn, 2015).

In this respect, we argue the "external conceptual boundaries" is similarly worthy of further investigation: what are the conceptual demarcations between the ecosystem and other relevant concepts, such as strategic supply chains, strategic networks and even strategic alliances? With such answers, the ecosystem's conceptual rigor would be further enhanced.

Second, researchers have noted, especially in information and communication industries, a more complex phenomenon—"the overlapped ecosystems" (Gueguen, Gael, 2009, Gueguen, Gaël & Isckia, 2011). For example, two ecosystems only share the same focal firms or platforms; two ecosystems have different focal firms but share part of the same non-focal firms; one firm plays the focal role in an ecosystem while acts as the non-focal role in the other. In concern of these situations, the firms (focal or not) have to deal with different roles if they act in more ecosystems, which could lead to role ambiguity and conflict. Further, when confronted with these challenges, managers are propelled to navigate their focus from an independent ecosystem to two overlapped ecosystems simultaneously. This leads to interesting research avenues to answer the questions such as: if the focal firms lead two ecosystems, how do they balance the internal coopetitive relationships among actors and the external coopetitive relationships between two overlapped ecosystems? Accordingly, would the non-focal firms who are the members in two overlapped ecosystems obtain more opportunities than others?

Third, we argue that measuring the health and performance of the ecosystem might need further endeavors. Although few extant studies have measured the ecosystems' health or performance with empirical data (e.g., Iansiti & Richards, 2006; Ben Hadj Salem Mhamdia, 2013, Graça & Camarinha-Matos, 2016), they are challenged by the criticisms that the

performance indicators are incomplete or too subjective and such measurements face inapplicability in other ecosystems or industries. Furthermore, the output and value creating process are fundamentally different within diverse subtypes of ecosystems. Typically, as concluded by van Angeren et al. (2016: 443): "software ecosystem health metrics need to be individually formulated for each ecosystem". We propose, in any empirical studies, the metrics should be linked and adjusted to the level of analysis, their research question and ecosystem type. We suggest that the twelve features that we propose in this study are a solid basis to develop sound empirical metrics.

Fourth, although the ecosystem is a category of inter-organizational phenomenon and theorists define it as "a community of organizations, institutions and individuals that impact the enterprise and the enterprise's customers and suppliers" (e.g., Teece, 2007: 1325). Whereas most studies focus on the organization-ecosystem level analysis, still little is known about individuals and their influences on the ecosystem they are involved with (Mäkinen et al., 2014). Our conceptualization of internal boundaries offers cross-level perspectives to study the micro-foundations of the ecosystems.

More specifically, in our review, we notice that the start-ups/entrepreneurial ecosystem extend the business and innovation ecosystem by extra highlighting the entrepreneurs' individual function (e.g., Rampersad, 2016; Laužikas et al., 2015). Then more research is needed to understand how entrepreneurs' strategic thinking (insight and foresight) impacts their decisions as to join in, collaborate with actors and exit to an ecosystem, and how do they heuristically regulate themselves to sense and exploit the market or technological opportunities in an ecosystem?

4.4 Limitations

This review have some limitations to be noticed. First, the findings deriving from descriptive statistics and content analysis are exclusively depended on the peer-reviewed studies, for which, to some extent, the reliability has been eroded without a consideration of diverse resources, such as the conference papers, working papers and even public web pages. Second, the single qualitative analysis restricts our argumentations. For example, the results of the descriptive statistics and three application routes could have been optimized with the complements of bibliometric tools. Third, even though we have followed a strict review procedure, the possible researcher bias still exist, especially in respect of addressing the subjective conflicts. Finally, our conceptualization does not specify the ecosystem as a spatial concept or a kind of geographical boundedness phenomenon, which impairs the conceptual rigor and would undermines the multi-layered connections between the ecosystem and other concepts such as clusters, technopolis and science parks (Pombo-Juárez et al., 2016; Majava et al., 2016a; Majava et al., 2016b).

5. Conclusion

Over two decades after Moore's introduction of the ecosystem concept in the management literature, diversified interpretations and inconsistent features generated by the following works have impeded the ongoing employment by scholars and practitioners, which further entails the clarified conceptual boundaries. We highlight the three-faceted conceptualization of the ecosystem which promotes more empirical and multi-level studies in future research. Hereby, the ecosystem with an even profound interpretation of its nature can show its full utilization in the real business world.

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