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# Roles during Innovation Ecosystem Genesis: A Literature Review

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## Abstract

This paper addresses recent calls to enhance our understanding of innovation ecosystem genesis, focusing in particular on the roles that come to prominence during this important yet volatile phase in the innovation ecosystem lifecycle. To this end, we undertook a systematic review of the literature, which has allowed us to study in detail 60 publications appearing in journals and conference proceedings. Our results propose several roles seminal to innovation ecosystem birth, which we have collated thematically into four groups – leadership roles ('ecosystem leader' and 'dominator'), direct value creation roles ('supplier', 'assembler', 'complementor', and 'user'), value creation support roles ('expert' and 'champion'), and entrepreneurial ecosystem roles ('entrepreneur', 'sponsor', and 'regulator') – and defined in terms of the specific activities they carry out during ecosystem birth. Furthermore, our findings tentatively suggest the entrance of these roles at different times as the process of genesis unfolds. Particular roles, such as the champion, are likely to be pivotal in ensuring that the innovation can move successfully from discovery to its commercialization. We conclude our paper by discussing future research avenues that can build on our role typology, to shed further light on the process of innovation ecosystem genesis.



**Keywords:** innovation ecosystems; ecosystem genesis; birth phase; ecosystem roles; literature review

## Introduction

Innovation ecosystems describe the collaborative effort of a diverse set of actors towards innovation, as suppliers deliver key components and technologies, various organizations provide complementary products and services, and customers build demand and capabilities (Moore, 1996). In this systemic context, firms acquire a competitive advantage by recognizing the holistic value embedded in products and services delivered to the customer (e.g. Ethiraj and Posen, 2013; Mäkinen and Dedehayir, 2013). Topics such as the collaboration between organizations, the creation and the capturing of value by actors, and the leadership of ecosystems have subsequently garnered growing interest from practitioners as well as scholars (e.g. Cusumano and Gawer, 2002; Adner and Kapoor, 2010; Ander, 2012). Notwithstanding, there have been recent calls to enhance our understanding of how innovation ecosystems come into existence in the first place (Gawer, 2014; Autio and Thomas, 2014). While ecosystem genesis has received very limited attention hitherto, it is a topic that is likely to carry substantial implications not only for practitioners and scholars alike, but also for policy makers whose efforts are directed towards promoting economic welfare within sectors, regions, and nations. The process of innovation ecosystem genesis is important to understand for these stakeholders, as this period in the evolution of the ecosystem is likely to be volatile, such that a viable collaborative network may fail to come into existence in the absence of necessary conditions, resources, and activities.

Motivated by this general line of inquiry, this paper addresses the genesis of innovation ecosystems, specifically focusing on the roles that are enacted during this process. Following Moore’s (1993; 1996) four-phased description of the innovation ecosystem lifecycle, we

conceptualize ecosystem genesis (i.e. the ‘birth’ or ‘pioneering’ phase) as the span of time that stretches from an initial discovery or invention, to the commercialization of an innovation. This is a period pronounced by the challenge of defining “value”, as visionaries and entrepreneurs “focus on identifying the particular seed innovations, whether technologies or concepts, that will create radically better products and services than those already available” (Moore, 1996, p. 70). We additionally borrow insights from role theory (e.g. Biddle, 1986), to study the appearance of particular roles, enacted by various actors on “stage”, as the genesis of the innovation ecosystem unfolds over time (e.g. Battistella et al., 2013). By defining ‘role’ as a characteristic set of behaviors or activities undertaken by ecosystem actors, our study aims to comprehend how innovation ecosystems are created as different types of roles take center stage during this period.

To divulge the roles that come to prominence throughout ecosystem birth, we conduct a review of the innovation ecosystem literature. In this endeavor, we use keyword searches to scour the ISI Web of Science database and apply filters to arrive at a relevant collection of publications appearing in journals and conference proceedings (N = 60). We, in turn, analyze the contents of these publications to allow the emergence of roles seminal to the process of ecosystem genesis.

Our paper is structured as follows. We begin by introducing Moore’s (1993) lifecycle depiction of ecosystem evolution, focusing specifically on the birth phase portrayed in this model. Next, we describe our methodology, and then present the results of our review of the literature. Our main contribution is a typology of roles that come to prominence, defined by the activities they enact during ecosystem genesis. We conclude our paper by proposing several possible extensions of our work to shed further light on the process of innovation ecosystem birth.

## Theoretical Background

Innovation ecosystems refer to heterogeneous constellations of organizations, which co-evolve capabilities in the co-creation of value (Moore, 1993; Adner and Kapoor, 2010; Autio and Thomas, 2014). Producers, suppliers, distributors, financial and research institutions, makers of complementary technologies, and regulatory bodies are just some of the organizations that constitute the innovation ecosystem (e.g. Mäkinen and Dedehayir, 2013). There are defining traits holding innovation ecosystems as distinct from similar or overlapping constructs depicting organizational networks, such as clusters (e.g. Porter, 1998) and value networks (e.g. Christensen and Rosenbloom, 1995). Clusters refer to “critical masses – in one place – of unusual competitive success in particular fields” (Porter, 1998, p.78). Examples of such clusters include the Silicon Valley, Boston’s Route 128 corridor, North Carolina’s Research Triangle Park, Hollywood, Wall Street, and the Californian Wine Cluster (e.g. Bresnahan et al., 2001; Porter, 1998). As a conceptual framework, clusters allow the study of regional competitiveness and economic performance, with the co-location of businesses increasing the productivity of companies, driving innovation, and stimulating the formation of new businesses. The regional focus of the cluster distinguishes it from the innovation ecosystem, the boundary of which is not defined by a specific geographical location but rather by a ‘collective functionality’ constituting a functional barrier. Indeed, innovation ecosystems of firms such as Apple and Google span the globe and coalesce a myriad of actors in the co-creation of value. By comparison, the value network depicts a complex, interconnecting web of direct and indirect ties among a group of actors, which create value for customers through the products and services that are manufactured (Basole and Rouse, 2008; Lusch et al., 2010). The network can be seen as a nested, hierarchical

system of manufacturers and markets, which produce as well as purchase the corresponding nested hierarchy of components, products, and holistic systems (Christensen and Rosenbloom, 1995; Christensen, 1997, p.225). In this manner, the value network framework allows the study of connecting structures, but remains relatively silent on the dynamics of these connections. Given its biological origins, innovation ecosystems differ from value networks by focusing on the co-evolutionary processes taking place as various organizations (akin to species) interact, often in symbiosis. A further distinct feature of the innovation ecosystem construct, in comparison to other overlapping depictions of organizational networks, is the inclusion of end-users in amongst this constellation (Autio and Thomas, 2014). Innovation ecosystems can consequently be viewed as being centered about a platform that brings providers of products and services into exchange with the users of these products and services (Thomas and Autio, 2013; Gawer, 2014). While platforms typically connect individual consumers to value creating organizations (e.g. the platforms of Apple and Google), some contemporary platform-based ecosystems (e.g. those of Über and Airbnb) demonstrate that individuals can simultaneously assume the role of provider as well as consumer of products and services.

Since Moore's (1993; 1996) seminal publications, a number of scholars have made important contributions to the relatively nascent innovation ecosystem field of inquiry. These include Cusumano and Gawer (2002), who discuss the strategic considerations of actors that constitute the innovation ecosystem, underlining the provision of platforms (e.g. tools, technologies, manufacturing processes, and services) as the key to the success of ecosystem leadership. Iansiti and Levien (2004), in turn, discuss organizational strategies in relation to innovation ecosystems and offer measures of ecosystem performance, while Adner (2006), and Adner in a series of subsequent papers together with Kapoor (e.g. Adner and Kapoor, 2007;

Kapoor and Adner, 2007; Adner and Kapoor, 2010), highlight the centrality of performance discrepancies that appear and curb innovation ecosystem development. Building on these earlier works, Adner (2012) introduces methods for: (i) designing the ecosystem's 'value blueprint' (i.e. locations and links between ecosystem actors); (ii) foreseeing risks to value creation; (iii) determining the value of leadership and followership roles in the ecosystem; (iv) timing of innovation introductions; and (v) the dynamic reconfiguration of the ecosystem over time. And more recently, Autio and Thomas (2014) provide a review of the literature to shed light on the boundaries, structure, and management of innovation ecosystems, while Gawer (2014), and Gawer and Cusumano (2014) offer an overarching conceptualization of platforms, distinguishing between 'internal platforms' that comprise a firm and its sub-units, 'supply-chain platforms' that comprise assemblers and suppliers, and 'industry platforms' (akin to innovation ecosystems) that comprise a platform leader and its complementors.

These central themes hitherto examined by scholars (e.g. organizational strategies pertaining to value creation, value capture, and ecosystem leadership, the configuration of ecosystem value blueprints, and the structure of ecosystems), are contingent on the evolution of the innovation ecosystem. Conceiving ecosystem evolution to follow a stylized lifecycle, Moore (1993; 1996) proposes that ecosystems progress through four phases - birth, expansion, leadership, and self-renewal (or death). The birth phase is pronounced by a common understanding of the product and service requirements of the customer by all members of the ecosystem. This understanding guarantees the collaboration of actors towards common objectives. The ecosystem expands into new territories of application in the second phase. It is possible that rivalries eventuate as the same application realm may be targeted by different ecosystems. Expansion into new territories requires the stimulation of market demand albeit within the capacity of the ecosystem, and it is

therefore vital that the ecosystem leader is able to maintain strong relationships with the customer as well as suppliers and complementors (Moore, 1993). The third stage of ecosystem evolution is a period of consolidation and establishment. This stage centers on determining ecosystem leadership and the attainment of stability in the ecosystem's sub-systems and processes. These foundations, together with a clear vision of future development, enhance the commitment of component suppliers and complement producers, thereby institutionalizing a true network of cooperators (Moore, 1993). And the final stage is a response of the mature ecosystem to emerging threats from new ecosystems and innovations, or significant upheavals and alterations in the ecosystems environment, such as those pertaining to government regulations and demographic traits, which create opportunities for new ecosystems to emerge. There are two possible reactions to these challenges: the ecosystem's self-renewal or death. For the former, ecosystem leaders play a vital role in either slowing down the development of new, threatening ecosystems, or generating new innovations and creating a fundamental restructure of their own ecosystems. If self-renewal cannot be put into practice, then the inevitable outcome of an ecosystem is one of death (Moore, 1993).

In this paper we focus on the period of innovation ecosystem birth, which is a vital precursor to the sequential phases that are to follow. To date there have only been a handful of purposeful scholarly examinations of the process of ecosystem genesis. Garnsey and Leong (2008), firstly, illustrate how new ventures in the pharmaceutical sector negotiate constraints presented by the selecting environment during the process of bringing a medicinal product to the market. The authors utilize the notion of a 'transaction environment' to analyze a firm's interaction with other actors in its immediate vicinity, showing the influence of regulatory institutions in promoting or prohibiting the innovations of pharmaceutical firms, the mediation of customer preferences by

physicians and hospitals, and the legitimization of organizational activities by public opinion. Thomas and Autio (2013; 2014), in turn, examine the emergence of six digital service platform ecosystems. Their results suggest the centrality of four activities for ecosystem emergence: (i) resource activities - the acquisition and management of resources by the hub firm; (ii) technological activities - the design and provision of technologies; (iii) institutional activities - the establishment and implementation of rules of engagement; and (iv) context activities (e.g. regulatory activities) - stimuli sourced from the environment that influence the operation of the ecosystem. The process of emergence revealed by the authors comprises three phases, namely, initiation, momentum, and optimization, which closely align with the birth, expansion, and leadership phases described by Moore (1993). And in a recent examination of the birth and expansion phases of a copper production ecosystem, Dedehayir and Seppänen (2015) propose that the ecosystem's birth phase is marked by two sub-phases – invention and start-up. The invention sub-phase is deemed to stretch from the discovery and testing of a new technology until the first demonstration of the technology's operation, and is followed by the start-up sub-phase which persists until the first commercial application of the technology.

The birth phase of the innovation ecosystem lifecycle described by Moore and examined by later scholars aligns to some extent with the front end of product innovation, in other words, the period that spans from the initial discovery of a product opportunity to the commencement of the NPD (new product development) process. In contrast to later stages in the product development process, the fuzzy front end is highly iterative and nonlinear (Kim and Wilemon, 2002). One of the reasons is that in this early stage multiple aspects have to be envisioned, such as the product concept itself, its production process, and the distribution and marketing to customer segments. All of these aspects are uncertain at first and need to be envisioned to form a consistent whole.

Frishammar et al. (2013) for example show how the definition of the product concept and its production process interact to form an iterative process. They indicate that the process of defining a product concept and a production process are significantly different and therefore difficult to align. Hence, an iterative, non-linear and somewhat chaotic process during the fuzzy front end emerges. This preliminary stage of product development is therefore volatile and in the absence of formal roles, processes, and resources, the commercialization potential of an invention can simply disappear. However, as Markham et al. (2010) stress, informal roles and activities are likely to be equally necessary to transition across this span of time. This is because while the formality of roles and processes during the research phase leading to discovery, as well as the NPD phase leading to a commercializable product, are accompanied by the availability of resources, the temporal gap between these phases can be pronounced by limited resource endowments. To negotiate this so-called ‘valley of death’, roles and activities beyond the formal organizational structure are needed to move projects from idea to NPD.

Markham et al. (2010) examine three informal roles in the innovation process: (i) champions; (ii) sponsors; and (iii) gatekeepers. Champions identify new ideas that hold promise for transformation into future products. To catalyze this process, champions ultimately engage in internal marketing, by preparing the idea for acceptance by others in the organization (Howell and Higgins, 1990). Importantly, they require the assistance of the sponsor to provide support (e.g. top management support, technical resources, and financial resources) for the initiated project that is yet to receive formal acceptance (Roberts and Fusfeld, 1981; Tighe, 1998). Together, the champion and sponsor aim to bring the idea to the NPD process, to which end they must acquire the acceptance of the gatekeeper, “who sets decision criteria and who provides access to resources for projects that meet this criteria” (Markham et al., 2010, p.407).

The centrality of informal roles is even more pronounced for the formation of innovation ecosystems, which do not have formal organizational structures. As a result, the presence of ecosystem roles are likely to be naturally emergent rather than being prescribed by external governance mechanisms. The ‘ecosystem leader’ and the ‘complementor’ are two quintessential roles that have been pervasively used in the innovation ecosystems literature thus far. For instance, Moore (1993) proposed that in the volatile phase of ecosystem birth, the ecosystem leader assumes a central position by securing the cooperation of key organizations which will provide complementary products and services in the co-creation of value to the customer. He further underlines the importance of the ecosystem leader to protect the new innovation idea from competitors, while at the same time forging strong ties with lead customers and important channels of delivery. The role of complementor, in turn, subsumes the activities that will help the ecosystem leader expand the realms of its application. Cusumano and Gawer (2002) illustrate this in their study of Intel and Microsoft, the firms that hold the co-leadership role of the PC (personal computer) ecosystem, and the large number of firms that assume the role of complementor by offering hardware and software products complementary to Intel and Microsoft’s platform.

In this paper, we nevertheless aim to divulge the full cast of roles that come to prominence during the crucial birth phase of ecosystem evolution. A comprehensive list of roles will enable stakeholders to plot the sequence of their emergence, and the sequence of activities they enact, necessary to traverse the period of innovation ecosystem birth. We importantly underline that roles are distinct from actors, and that the latter will assume a particular role at a given point in time. Considering the dynamic nature of ecosystem genesis, we additionally contend that actors can enact different roles over time, and further, that the intensity of participation of a particular

role may vary throughout this period (Markham et al., 2010). In sum, the cast of informal roles and the timing of their entrance onto the stage of ecosystem genesis are highly valuable for different stakeholders to recognize in ensuring that the roles are occupied by actors that can perform crucial activities.

**Methodology**

To understand the birth of innovation ecosystems, with a focus on the roles and activities that take center stage during this crucial phase of ecosystem evolution, we conducted a survey of the literature. For this study we consulted the ISI Web of Science database in October 2015, and following a sequence of steps, identified the group of highly relevant publications to be used in our review. We began by using the term *ecosystem** to search in the titles of all publications listed in the database. This strategy was premised on our objective to obtain the most topically focused set of works, which we deemed would contain the ‘ecosystem’ term in their titles. This initial step yielded over 38000 publications without discrimination of scientific disciplines. We subsequently undertook a second step to refine this result, and to identify only those publications belonging to the ‘management’ and ‘business’ disciplines, as classified by the Web of Science, which provided a list of 371 scientific papers.

The authors, in turn, scoured the abstracts of these publications independently, to underline those which were judged to be most relevant to the line of inquiry driving the research, namely, the genesis of innovation ecosystems. Following independent analysis, the authors reconvened to compare their notes to identify commonalities in their judgements, and to collectively review any discrepancies. The resulting list of articles constituted a total of 90 publications appearing in journals and conference proceedings. After reading these through, a proportion of the

publications were identified as not providing a contribution to the goals of our work and were therefore left out of our study. We finally arrived at a list of 60 scholarly works, which capture the most pertinent and contemporary corpus of literature to be used in this literature review.

We documented two groups of information from the articles. First, we collated background information focusing on the empirical aspects of the corpus of literature, including the empirical context examined and the methodology employed by the authors. Second, and in line with the research question driving our investigation, we analyzed the actors that engaged in some activity in the empirical studies presented in the literature, along with the traits (i.e. properties of the actor that determine its engagement in activities) and actions (i.e. activities that the actor engages in related to the birth of the ecosystem) of these actors. We then reviewed the resultant dataset to allow the emergence of roles enacted by the actors.

Drawing on a theatrical metaphor, role theory defines 'role' as a part or an identity in a social system recognized by others in that system, for which there may be a 'script' or "expectations of behavior that are understood by all and adhered to" by the actor (Biddle, 1986, p. 68). Whilst role theory is typically concerned with the roles of individual persons who are members of social positions, we contend that various entities, whether individual, group, or organizational, can assume roles in any social system, including innovation ecosystems. Hence, aligning with role theory, we define a role in the innovation ecosystem as characteristic behaviors enacted by entities (or actors). Consequently, by employing this definition in our analysis of the literature, we were able to recognize roles as those grouping and reflecting particular sets of activities (i.e. characteristic behaviors). These emergent roles were assigned labels to represent the specialized activities that define them, and in turn, collated in thematic

groups (i.e. meta-level constructs) to help structure the roles that enter the stage of innovation ecosystem genesis.

## Results and Discussion

### *Empirical context of selected studies*

In the first part of our analysis we studied the empirical contexts examined by the scholars as well as the methodological approaches employed in these examinations. We summarize our findings in Table 1.

Table 1: Overview of the literature studying innovation ecosystem genesis.

| Empirical Context | Qualitative | Quantitative | Conceptual | Sum |
|---|---|---|---|---|
| ICT | | | | 29 |
| *generic* | Adomavicius et al., 2007;<br>Williamson and de Meyer, 2012;<br>Ritala et al., 2013;<br>Gawer and Cusumano, 2014;<br>Letaifa, 2014;<br>Chang, 2015;<br>Bosch-Sijtsema and Bosch, 2015 | Still et al., 2014 | | *8* |
| *internet* | Isckia, 2009;<br>Li, 2009;<br>Qu and Ye, 2010 | Zacharakis et al., 2003;<br>Weiss and Gandagharan, 2010;<br>Tiwana, 2015 | | *6* |
| *mobile telecomm.* | Rohrbeck et al., 2009;<br>West and Wood, 2013;<br>Rong et al., 2013b | Basole, 2009;<br>Mäkinen, et al., 2014 | Tan and Gao, 2011 | *6* |
| *software* | Wareham et al., 2014 | Iyer et al., 2006 | Popp, 2010 | *3* |
| *e-commerce* | Hu et al., 2009;<br>Gomez-Uranga et al., 2014 | | | *2* |
| *PC* | | Ethiraj and Posen, 2013 | Mäkinen and Dedehayir, 2013 | *2* |
| *digital imaging* | Battistella et al., 2013 | | | *1* |
| *semiconductor* | | Adner and Kapoor, 2010 | | *1* |
| Medical | Maracine and Scarlat, 2008;<br>Li and Garnsey, 2013;<br>Li and Garnsey, 2014 | Kapoor and Lee, 2013 | | 4 |
| Entrepreneurial | Kshetri, 2014;<br>Fernandez et al., 2015 | MacGregor and Madsen, 2013 | | 3 |
| Research | Leten et al., 2013;<br>Maia and Claro, 2013 | Clarysse et al., 2014 | | 3 |
| Energy | Ginsberg et al., 2010;<br>Overholm, 2015 | | | 2 |
| Transportation | Rong et al., 2013a;<br>Lindgren et al., 2015 | | | 2 |
| Government | Almirall et al., 2014 | | | 1 |
| Insurance | Vaia et al., 2012 | | | 1 |
| Restaurant | Chesbrough et al., 2014 | | | 1 |
| Toys | Hienerth et al., 2014 | | | 1 |
| Textile | Ramachandran el al., 2012 | | | 1 |
| Tech. park | van der Borgh et al., 2012 | | | 1 |
| High-tech | Best, 2015 | | | 1 |
| none | Adner, 2006;<br>Weill and Woerner, 2015 | | Ayres, 1996;<br>Pitelis, 2012;<br>Choi and Phan, 2012;<br>Jucevicius and Grumadaite, 2014;<br>Isckia and Lescop, 2014; | 10 |

| | | | | |
|---|---|---|---|---|
| | | | Kumar et al., 2015; Vargo et al., 2015; Gastaldi et al., 2015 | |
| **Sum** | 37 | 12 | 11 | 60 |

A variety of empirical contexts have been studied in the literature, although a significant proportion of these (approximately half of the full set of articles) belong to the ICT (information and communications technology) context. This is an interesting finding and suggests that scholars have been interested in the implications of ecosystem creation in this setting more so than in others. At the same time, the table indicates the relatively limited attention other contexts have received from scientific inquiry. Overall, the imbalance in empirical settings may limit our understanding of ecosystem genesis to what transpires predominantly in the ICT sector, and would therefore call for much needed extension of investigations in a wider scope of contexts.

The overview table additionally lists a very large portion of qualitative (e.g. those employing case studies) and conceptual papers (i.e. those providing merely theoretical discussion with no empirical examination), totaling to 48 out of the cohort of 60 papers. This is not a surprising finding, however, as we would expect to observe a higher number of qualitative as well as conceptual contributions for emerging topical areas such as the innovation ecosystems research stream. The objective of these contributions are likely to focus on developing conceptual models that can explain the phenomenon in question (e.g. ecosystem genesis), to be later followed by an increasing number of quantitative studies that aim to test hypotheses and refine the conceptual models as the topical area matures (Edmondson and McManus, 2007).

### *Roles in innovation ecosystem emergence*

In the second part of our study, we aimed to underline the roles pertinent to ecosystem genesis from the analysis of the actors and their actions as described in the reviewed literature.

Our study revealed several key roles, which we collated thematically into four groups – leadership roles, direct value creation roles, value creation support roles, and entrepreneurial ecosystem roles.

*Leadership roles*

In Table 2 we firstly present leadership roles that emerged from our analysis, along with the activities that define these roles, and the actors that have assumed these roles as illustrated in the literature we have examined.

Table 2: Leadership roles in the genesis of innovation ecosystems.

| Role | Activity | Actors (examples from literature) |
|---|---|---|
| **ecosystem leader** | | |
| *ecosystem governance* | initiates, maintains, and develops ecosystem functionality by:<br>(i) designing roles of ecosystem actors<br>(ii) coordinating internal and external interactions<br>(iii) orchestrating resource flows between partners | - Alibaba in the e-marketplace ecosystem (e.g. Hu et al., 2009)<br>- Swedish Road Administration in the traffic management ecosystem (e.g. Lindgren et al., 2015) |
| *forging partnerships* | creates a network by:<br>(i) attracting and gathering relevant partners together<br>(ii) forming links and alliances with firms owning various resources from different industries<br>(iii) creating collaboration between parties in alliances<br>(iv) stimulating complementary investments and providing opportunities for niche creation | - Microsoft in the software ecosystem (e.g. Popp, 2010)<br>- lithography tool producer in the semiconductor lithography equipment ecosystem (e.g. Adner and Kapoor, 2010)<br>- Cisco, IBM, and GE in respective smart grid energy ecosystems (e.g. Ginsberg et al., 2010)<br>- medical diagnostics firm in the Tuberculosis diagnostics ecosystem (e.g. Li and Garnsey, 2013) |
| *platform management* | provides technical basis for market to function by:<br>(i) designing and building a platform<br>(ii) opening platform, data, and infrastructure to build user-community and enhance value from producers<br>(iii) orchestrating complementor innovations to align with platform | - Amazon in the e-retailing ecosystem (e.g. Isckia, 2009)<br>- city officials in the public government ecosystem (e.g. Almirall et al., 2014)<br>- Lego in the children toys ecosystem (e.g. Hienerth et al., 2014)<br>- Deutsche Telekom in the telecommunications ecosystem (e.g. Rohrbeck et al., 2009) |
| *value management* | creates and captures value by:<br>(i) bundling offerings and supplied components<br>(ii) stimulating value appropriation for all producers and the end-user | - hospitals in the healthcare ecosystem (e.g. Kapoor and Lee, 2013)<br>- orchestrator in the public research ecosystem (e.g. Leten et al., 2013) |
| **dominator** | conducts mergers and acquisitions in related fields | - Cisco in the internet infrastructure ecosystem (e.g. Li, 2009) |

A significant percentage of the literature we examined focused on the actions of a central actor, which undertook a leadership role in the birth of the innovation ecosystem. We interpreted this outcome to suggest the indispensability of such a central role for ecosystem genesis, and

consequently labelled it as the ‘ecosystem leader’, aligning with Moore’s (1993) own conceptualization, and enveloping the notions of ‘keystone’ (Iansiti and Levien, 2004), ‘platform leader’ (Cusumano and Gawer, 2002), and ‘hub’ (Iyer et al., 2006). Collectively, the scholars listed a large number of activities that define the ecosystem leader, which we have collated under four higher-level sets of activities – ecosystem governance, forging partnerships, platform management, and value management.

An actor assuming the role of ecosystem leader during genesis will firstly engage in governance related actions. These include designing the role of other actors and coordinating the interactions between them. Although these activities are needed throughout the phase of ecosystem birth, we believe that they are especially important in the very early stages of ecosystem creation when actors begin to coalesce but lack structure in their interconnections. The ecosystem leader can subsequently catalyze and accelerate the process of coalescence, a task pertinent for ecosystems that are not platform-centric and lack a technical platform which will act as a focal “building block” (Gawer, 2014). For example, in their analysis of the Swedish Road Administration’s (SRA’s) implementation of the Radio Data System – Traffic Message Channel (RDS – TMC) traffic information service, Lindgren et al. (2015) illustrate how the SRA (i.e. the ecosystem leader) overcame legitimization challenges by negotiating new roles. Another governance related activity is the orchestration of resource flows among coalitional members. We anticipate this activity to gain significance at later stages of ecosystem birth, when resources (e.g. technological and financial) begin to accumulate and therefore need to be managed more purposefully. Overall, we expect the governance activities undertaken by the ecosystem leader (e.g. coordinating interactions and orchestrating resource flows) in innovation ecosystems that are not platform-centric to take the form of ‘relational governance’ rather than a transaction cost

mode of exchange (e.g. Zaheer and Venkatraman, 1995; Poppo and Zenger, 2002). Following this proposition, leaders of such ecosystems would be encouraged to build relationship-specific assets and interorganizational trust in governing the ecosystem, with less reliance on formal, complex contracts in interorganizational exchange[1].

The second group of activities the ecosystem leader will undertake are the forging of partnerships. Li and Garnsey (2013) exemplify this in their study of the tuberculosis diagnostics ecosystem, whereby the medical diagnostics firm (i.e. ecosystem leader) has been able to garner the needed value from partnerships in circumventing risks associated with the discovery, development, and delivery of healthcare innovations to BoP (bottom-of-pyramid) markets. Forging partnerships commences with the attraction of actors to join the network, which is likely to take place during the early period of ecosystem birth when a critical mass is yet to be attained. In this effort, the ecosystem leader may provide incentives for external partners to engage with the nascent network. Once actors begin to gather, the ecosystem leader's next task is to form links between them towards the creation of an alliance. This is likely to involve the leader's intermediacy among partners that may come together from different industrial origins. Creating collaboration within the emerging network of actors follows in turn, and should result in collective action towards a common objective, namely, the creation of holistic value embedded in new products and services. A likely challenge facing the ecosystem leader in this endeavor is the sharing of its vision with the network of actors, and the acquisition of consensus among them to attain true collaboration. In parallel, the ecosystem leader will stimulate the commitment of complementarities, which can enhance the application realm of the core product or service developed by the interconnected set of actors. We expect this activity to take place near the

[1] We are grateful to the anonymous reviewer for underlining this issue in ecosystem governance.

conclusion of the birth phase, as the ecosystem prepares to enter the expansion stage in its lifecycle (Moore, 1993).

Following the propositions of Cusumano and Gawer (2002) in particular, several scholarly works have drawn attention to platform-based ecosystems, and the activities of the platform leader (e.g. Amazon in e-retailing, and Lego in toys). Here, by platform we refer to a technical premise upon which a market of producers and consumers can function. And whilst we contend that innovation ecosystems may or may not be platform-based in their design, for ecosystems that do center about a platform, there appear to be a distinct set of activities the ecosystem leader needs to undertake. These platform management activities firstly include the designing and building of the platform. Following this fundamental step, the ecosystem leader aims to generate value from the participation of a host of actors, including a user-community and the group of producers. Hence, it opens up the platform to allow the multitude of actors to join the milieu by exchanging ideas and engaging in transactions. Rohrbeck et al. (2009) illustrate the benefits of opening up the platform in their study of Deutsche Telekom, which successfully improved its innovation capacity by internalizing the creativity and knowledge of external resources. A further task of the leader of a platform-based ecosystem is to ensure the compatibility of the scope of complementary innovations with the platform, a necessary condition for a functional market.

The fourth and final set of activities that define ecosystem leadership is the management of value. More specifically, the ecosystem leader creates and captures value by producing its own offerings and/or aggregating the offerings of other actors in the ecosystem, and at the same time ensures that other actors can accrue their own value. Kapoor and Lee's (2013) examination of the different forms of alliance formed by the hospital (the ecosystem leader) and physicians in the

healthcare ecosystem, exemplify how technological investments can influence the ecosystem leader’s manner of value capture. Value appropriation of other actors is especially pertinent for a healthy ecosystem that can maintain the subscription of actors, which are satisfied with the amount of value they can appropriate from the market they interact with (Iansiti and Levien, 2004). The ecosystem leader role we define is in this manner a benevolent one, concerned with the wellbeing of the ecosystem.

By contrast, the second of the leadership roles that emerged from our review of the literature – ‘the dominator’ – denotes a different style of governance. An actor that assumes the dominator role will undertake vertical and horizontal integration of actors in the innovation ecosystem, as demonstrated by Cisco’s mergers and acquisitions (Li, 2009). With the increasing control the dominator is able to muster over the ecosystem through such actions, the value actors can appropriate from the ecosystem will be significantly reduced, and the desirable function of the ecosystem in its entirety will begin to diminish, potentially leading to its collapse (Iansiti and Levien, 2004). In relation to the birth of innovation ecosystems, we believe that the dominator role may enter in its later stages when there is sufficient value to control, albeit to the possible demise of the ecosystem.

*Direct value creation roles*

The leadership role is crucial for ecosystem birth in ensuring the attainment of a critical mass and collaboration to deliver holistic value. The second group of roles that are essential for ecosystem genesis are those directly associated with value creation. Our review helped us identify four roles in this thematic group, as presented in Table 3.

Table 3: Direct value creation roles in the genesis of innovation ecosystems.

| Role | Activity | Actors (examples from literature) |
|---|---|---|
| **supplier** | delivers key component offering by supplying materials, technologies, and services, to be used by others in the ecosystem | - lens producer in the semiconductor lithography ecosystem (e.g. Adner and Kapoor, 2010)<br>- handloom artisans in the BoP textile ecosystem (e.g. Ramachandran el al., 2012) |
| **assembler** | provides products and services by:<br>(i) assembling components, materials, and services<br>(ii) processing information, supplied by others in the ecosystem | - waste consumer in the industrial ecosystem (e.g. Ayres, 1996)<br>- hospital in the healthcare ecosystem (e.g. Kapoor and Lee, 2013) |
| **complementor** | delivers key complementary offering by:<br>(i) attaining compatibility with the platform<br>(ii) utilizing the design of the ecosystem's other offerings<br>(iii) meeting customer specifications | - mask producer in the semiconductor lithography ecosystem (e.g. Adner and Kapoor, 2010)<br>- PC game software developers in the PC game ecosystem (e.g. Mäkinen and Dedehayir, 2013) |
| **user** | contributes to value creation by:<br>(i) defining a problem or need<br>(ii) developing ideas based on product data provided by ecosystem leader<br>(iii) engaging in transaction and purchasing of offering<br>(iv) integrating key complementarities and using the product or service | - patient in the healthcare ecosystem (e.g. Maracine and Scarlat, 2008)<br>- customer in the cloud computing ecosystem (e.g. Qu and Ye, 2010)<br>- customer in the electric vehicle ecosystem (e.g. Rong et al., 2013a)<br>- the user community in the Lego ecosystem (e.g. Hienerth et al., 2014) |

The roles listed in the above table denote those available for assumption in the traditional value chain – 'the supplier', 'assembler', and 'user' – together with a role that distinguishes the innovation ecosystem from the value chain, namely, the 'complementor'. More so than describing the position of actors along an extended value chain, however, the roles stipulated represent particular sets of activities undertaken by the actors. For example, the role of supplier refers to the activities that deliver key materials, technologies, and services for the usage of other actors in the ecosystem. According to this definition, any actor can hold the position of supplier as long as it oversees these activities, although in the traditional, linear depiction of value chains,

the supplier is likely to lie in an upstream position. The lens producer in the semiconductor lithography ecosystem (e.g. Adner and Kapoor, 2010), and the handloom artisan in the BoP textile ecosystem (e.g. Ramachandran el al., 2012) illustrate this role in different contexts. The role of assembler, in comparison, emphasizes the actions of aggregating received components, materials, and services, as well as the processing of information produced by others, to deliver products and services that result from this assembly. In this manner, the role of supplier and assembler are connected through the actions of delivery on the part of the supplier, and the receipt and assemblage of components on the part of the assembler, with each role contributing unique value to the ecosystem. As the assembler, the waste consumer in the industrial ecosystem receives input from the waste producer (i.e. supplier), which it integrates with other inputs to create useful products (e.g. Ayres, 1996). Similarly, hospitals in the healthcare ecosystem are assemblers that integrate their internal services with those of physicians to create holistic services for patients (e.g. Kapoor and Lee, 2013).

The innovation ecosystem literature underlines the complementor role as serving to extend the core offering of suppliers and assemblers. As such, the complementor role is occupied by actors lying off the direct path of value creation (Adner, 2012). For the complementor to contribute value to a platform-based ecosystem, its complementary offering needs to be compatible with the core platform. This requirement denotes the connection of the complementor with the ecosystem leader, which opens up its platform to invite complementary innovations. Complementary products and services are also required to function in conjunction with the offerings of other ecosystem actors and must be designed accordingly. The complementarity between hardware and PC game software products in the PC game ecosystem is highly illustrative of this requirement (e.g. Mäkinen and Dedehayir, 2013). At the same time, the

complementor must meet the specifications of the customer, given that the latter will accrue holistic value by bringing together the assembler's offering together with that of the complementor (e.g. Adner, 2010).

The final direct value creation role we have underlined is the user. Actors in this role contribute value to the ecosystem most importantly by defining a problem or need, which can be seen as the prime trigger for the genesis of an innovation ecosystem. The needs of patients in the healthcare ecosystem illustrate the user's influence on ecosystem formation (Maracine and Scarlat, 2008). Furthermore, users can be the source of innovation ideas, around which ecosystems are created. The engagement of the user community in the Lego ecosystem is exemplary in highlighting product ideas as drivers of ecosystem birth (Hienerth et al., 2014). Collectively, we anticipate the supplier, assembler, and the complementor roles to enter the stage of ecosystem genesis closer to its conclusion, when focal ecosystem activities shift from defining user needs and coalition formation, to addressing the needs through value creation (i.e. products and services).

*Value creation support roles*

The literature also notes supporting roles for value creation. These roles do not add value directly through the delivery of products and services (or the components or assembly processes), but do so by providing peripheral supporting elements. Table 4 lists the two emergent supporting roles of the expert and champion, along with the activities that define them.

Table 4: Value creation support roles in the genesis of innovation ecosystems.

| Role | Activity | Actors (examples from literature) |
| --- | --- | --- |
| **expert** | supports primary value creators by:<br>(i) generating knowledge from basic and applied research<br>(ii) providing consultation, expertise, and advice<br>(iii) encouraging technology transfer and commercialization | - university and public research organization in localized ecosystems (e.g. Clarysse et al., 2014)<br>- physician, medical staff, and specialist in the healthcare ecosystem (e.g. Maracine and Scarlat, 2008; Kapoor and Lee, 2013) |
| **champion** | supports ecosystem construction by:<br>(i) building connections and alliances between actors<br>(ii) interacting between partners and sub-groups<br>(iii) providing access to local and nonlocal markets | - EIT ICT Lab in the ICT ecosystem (e.g. Still et al., 2014)<br>- bridge (boundary spanner) in the packaged software ecosystem (Iyer et al., 2006)<br>- entrepreneur in the BoP textile ecosystem (e.g. Ramachandran el al., 2012) |

The role of ‘expert’ undertakes activities that are seminal to the genesis of innovation ecosystems. Typically the literature associates this role with actors such as universities and research organizations, which generate knowledge, inventions, and discoveries (e.g. Clarysse et al., 2014) that can be used by direct value creating actors in the development of products and services. The expert role also subsumes activities such as providing consultation and expertise. Maracine and Scarlat (2008) and Kapoor and Lee (2013), for instance, underline individual actors, such as physicians and other medical professionals, who hold the expert role during the birth of healthcare ecosystems. These knowledge creation and dissemination activities are likely to take place in the early stages of ecosystem birth, providing the knowledge base upon which the innovation and a corresponding ecosystem of actors can be constructed. A further activity owned by the expert is the promotion of technology commercialization, which we believe is likely to be undertaken near the conclusion of the birth phase, as the efforts of the ecosystem shift towards delivering the product or service to the user.

Although already contained within the ecosystem leader's partnership forging activities, our study indicates that building connections and interacting with different partners during ecosystem birth is especially important, and may be accomplished by actors additional to those holding the leadership role. Hence, we distinguish a role specialized in building connections between actors and requiring an aptitude in interacting with different partners to enable ecosystem genesis, which we have labeled as the 'champion'. In employing the champion label, we acknowledge the seminal works of prior scholars (e.g. Chakrabarti, 1974; Chakrabarti and Hauschildt, 1989; Howell and Higgins, 1990) that have underscored the role (often played by individuals) tasked with ensuring the safe transition of a new product idea from its inception to its commercialization. Notwithstanding, the champion role distinguished in the innovation management literature hitherto is one that resides within a single organization. Our literature review suggests that this role can indeed extend beyond the boundaries of one organization, to an interorganizational, ecosystem setting. For instance, Ramachandran et al. (2012) describe the entrepreneur as a champion, who helps construct the BoP textile ecosystem by connecting local BoP producers with international markets.

*Entrepreneurial ecosystem roles*

The final group of roles we have distinguished center primarily about the incipient ecosystem. We have identified three roles – entrepreneur, sponsor, and the regulator – which we have collated under the label of entrepreneurial ecosystem roles (see Table 5).

Table 5: Entrepreneurial ecosystem roles in the genesis of innovation ecosystems.

| Role | Activity | Actors (examples from literature) |
|---|---|---|
| **entrepreneur** | entrepreneur starts new venture around a vision by:<br>(i) co-locating in a region with others (agglomeration economies)<br>(ii) setting up focused network of staff, suppliers, customers, and complementors<br>(iii) coordinating collaboration between research and commercialization partners | - start-up in the internet hardware-software ecosystem (e.g. Zacharakis et al., 2003)<br>- entrepreneur in the restaurant ecosystem (e.g. Chesbrough et al., 2014)<br>- research entrepreneur in the biomedical research ecosystem (e.g. Li and Garnsey, 2014) |
| **sponsor** | supports new venture creation by:<br>(i) giving resources to entrepreneurs;<br>(ii) financing low-income markets<br>(iii) purchasing and co-developing offerings of firms<br>(iv) linking entrepreneurs to other ecosystem actors | - proof-of-concept center (PoCC) in the academic research ecosystem (e.g. Maia and Claro, 2013)<br>- ‘chaebol’ in South Korea's entrepreneurial ecosystem (e.g. Kshetri, 2014)<br>- policy makers in the biomedical research ecosystem (e.g. Li and Garnsey, 2014) |
| **regulator** | supports entrepreneurial activity and opening avenues for ecosystem emergence by:<br>(i) providing economic and political reform<br>(ii) loosening regulatory restrictions | - national government in South Korea's entrepreneurial ecosystem (e.g. Kshetri, 2014)<br>- political regulator in the ICT ecosystem (e.g. Chang, 2015) |

The ‘entrepreneur’, a role that is often held by individuals and start-up firms, is a vital component of a nascent ecosystem that will grow in time to provide economic welfare for regions, sectors, or nations. The entrepreneur is likely to be connected with other roles in the ecosystem. For example, this role may be assumed in response to the partnership forging activities of the ecosystem leader, or as a result of seeing opportunities to commercialize discoveries and inventions of experts. Our findings suggest that such drivers will motivate the entrepreneur to locate in a region populated by these interconnected roles, as well as other actors assuming the entrepreneur role. In parallel, the entrepreneur will establish a purposeful network of internal (e.g. staff and experts) and external collaborators (e.g. suppliers, customers, and complementors). Although partially overlapping with the activities enacted by the ecosystem

leader, the entrepreneur does not necessarily occupy the latter role, which additionally fulfils governance as well as value and platform management responsibilities. The entrepreneur also intermediates between actors conducting research (e.g. universities) and those aiming to commercialize technologies. As Li and Garnsey (2014) illustrate in their analysis of the biomedical research ecosystem, actors that engage in this activity can be referred to as research entrepreneurs.

Given that new ventures often lack resources, they require support from another entrepreneurial ecosystem role, which we have labelled as the ‘sponsor’, following Chakrabarti and Hauschildt (1989). However, giving financial assistance is not the only activity undertaken by actors in this role. The ‘chaebol’ in South Korea's entrepreneurial ecosystem, for instance, provides assistance to new ventures by co-developing their products and also purchasing them (Kshetri, 2014), while the proof-of-concept center (PoCC) in the academic research ecosystem connects potential new ventures with other actors such as mentors and provides business education (Maia and Claro, 2013). While the entrepreneur and sponsor form the core roles in the entrepreneurial ecosystem, they are supported by a third role which we have labelled the ‘regulator’. The contribution of this role is to catalyze the formation of new ventures by creating favorable economic, political, and regulatory conditions. Chang (2015) demonstrates the regulator’s influence on the dynamics of the ICT ecosystem in Korea by considering possible future scenarios in market changes in response to government policy.

### *Overview of roles during innovation ecosystem emergence*

Our study has allowed us to discern several roles important for ecosystem genesis, arranged in four thematic groups. Each of these roles is defined by a set of characteristic activities that

enable unique contributions to the genesis process. Moreover, our findings suggest temporality, such that particular activities are likely to be enacted ahead of others as the birth of the innovation ecosystem unfolds. In Figure 1, we provide an overview of these findings by summarizing the roles and respective activities that come to prominence across ecosystem emergence.

| | Role | Preparation | Formation | Operation |
|---|---|---|---|---|
| **Leadership** | Ecosystem leader | | | |
| | *ecosystem gov.* | decipher roles | coordinate interactions | orchestrate resource flows |
| | *forging part.* | attract & link partners | create collaboration | stimulate complementarity |
| | *platform man.* | build platform | open platform | orchestrate complementors |
| | *value man.* | | decipher bases of value | create & capture value |
| | Dominator | | | integrate actors |
| **Direct Value Creation** | Supplier | | | supply components |
| | Assembler | | | assemble components |
| | Complementor | | | provide complementarities |
| | User | define need | provide ideas | purchase and use |
| **Value Support** | Expert | generate knowledge | provide expertise | transfer technology |
| | Champion | | build connections | provide access to markets |
| **Entrep. Ecosystem** | Entrepreneur | co-locate | set-up network | |
| | Sponsor | give resources | co-develop offering | link to other actors |
| | Regulator | provide favorable conditions | | |

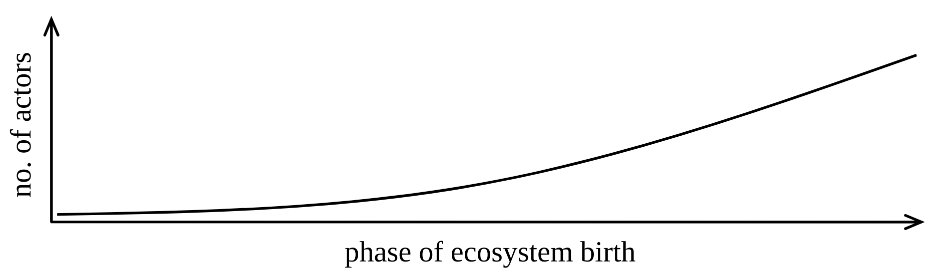


Figure 1: Roles and activities across the genesis of innovation ecosystems.

The innovation ecosystem's birth phase is reminiscent of the front end of innovation, which captures the activities that enable transition from discovery to the commercialization of an innovation. Given the uncertainties associated with this NPD period, the roles, as well as their

timing and influence, carry significance in successful transition (e.g. Markham et al., 2010). While the objective of our literature study has not been to divulge the timing of entry and the intensity of roles during ecosystem birth, it does nevertheless provide tentative suggestions as to the roles and the activities that are likely to come to prominence at different times across the period of genesis.

As Figure 1 illustrates, the ecosystem leader plays an intensive role throughout the phase of birth, with different activities undertaken at different times along the time dimension. By contrast, we expect the activities of the direct value creation roles to be enacted towards the conclusion of the birth phase, when value embedded in products and services can be delivered through supply, assembly, and complementarity of key components and technologies. An exception is the user role, which should enter the stage very early on to define the needs that motivate ecosystem formation. Another role that appears to be highly significant for the incipient ecosystem is the expert, which generates knowledge likely to provide the premise of solutions to satisfy user needs. The entrepreneur, with the support of the sponsor and the facilitating actions of the regulator, is also likely to enter the stage in this early period to spark the genesis process. Following the ‘valley-of-death’ hypothesis of Markham et al. (2010), the figure above also points towards seminal roles required to bridge the gap between the early and later stages of ecosystem birth. In addition to the ecosystem leader, the champion appears to be a crucial role to help the ecosystem navigate this volatile phase, recruiting key partners to join the network resulting in a gradual increase in the number of actors that constitute the ecosystem over time.

In addition to the entry timing of various roles, Figure 1 also suggests transitions to take place in the nature of the activities enacted by these roles over time. In its incipient, ‘preparation’ state, ecosystem activities center about constructing a premise and the establishment of necessary

conditions to stimulate the genesis process. The user needs are defined, scientific discoveries and inventions (i.e. the ingredients of innovation) are provided, the platform is built, initial contact with actors are made, and roles are deciphered, while entrepreneurs make location and resource preparations to commence the innovation process. The next group of activities give shape and purpose to the nascent innovation ecosystem, as the roles are redefined accordingly to meet this end. During this period of 'formation', interaction and collaboration between actors is enabled and the previously built platform is opened up to the innovation ecosystem participants. Users additionally contribute their ideas in light of the needs they had underlined earlier, while networks are established by the entrepreneur, supported in this initiative by the champion and sponsor. Following the preparatory and formation periods, the innovation ecosystem enters its third state, pronounced by activities resulting in holistic value creation. In this period of 'operation', roles are redefined once again as the ecosystem leader orchestrates collaborations and resource flows while concurrently creating and capturing its own value, and the expert, champion, and sponsor help solidify the extent of the network. It is nevertheless the direct value creation roles that power the innovation ecosystem during this time, through the supply and assembly of components and complementarities, as users acquire and put to use the value embedded in the final offering[2].

## Conclusions

[2] We are grateful for the suggestion of an anonymous reviewer to describe the patterns of innovation ecosystem emergence.

As innovation ecosystems gain burgeoning interest from practitioners, scholars, and policy makers, one of the fundamental questions pertain to how innovation ecosystems come into existence in the first place (Gawer, 2014; Autio and Thomas, 2014). Emergence is an important topic to study because this very early phase in the evolution of the ecosystem is likely to determine how it will be shaped and adapted later to deliver value embedded in its products and services. Several questions still remain unanswered in the literature: What are the actions that shape innovation ecosystems? What are the actors and their roles during ecosystem emergence? How does the innovation ecosystem evolve over time? To what extent is the emergence process predictive for later ecosystem performance? Knowing the answers to these questions could assist governments and market institutions to stimulate and facilitate ecosystem emergence, while concurrently helping key actors take the lead in innovation ecosystem formation. In this article our aim has been to address one of the key points of inquiry listed above, namely, to highlight the roles available for actors to enact during the genesis of innovation ecosystems. Our focus has been motivated by the fact that each instance of ecosystem birth involves multiple actors that take part in the process of formation and change. A detailed historical account offering a list of subsequent actors participating in ecosystem emergence would, nevertheless, fall short of theory and model building. Rather, to describe the process of ecosystem emergence we need to describe specific actions, which belong to and define particular roles. Distinguishing roles that comprise specific sets of actions cannot only simplify the complex process of ecosystem emergence, but also provide a common understanding that allows generalizations across multiple cases.

To identify roles and their activities we carried out a systematic review of the literature. From a detailed analysis of 60 relevant publications we revealed a number of key roles that are important to the genesis process, which we collated thematically into four groups: leadership

roles, direct value creation roles, value creation support roles, and entrepreneurial ecosystem roles. Each role within these groups were defined in terms of the specific activities they carried out during ecosystem birth. Our findings firstly suggest that the role of ‘ecosystem leader’ is indispensable for genesis, ensuring ecosystem governance, forging partnerships, management of a platform, and distribution of value. The ‘supplier’, ‘assembler’, ‘complementor’, and ‘user’, in turn, emerge as direct value creation roles, collectively delivering, assembling, and putting to use key components, complementarities, and products and services. The contributions of these roles are aided by the value creation support role of the ‘expert’, which generates and disseminates fundamental knowledge, and the ‘champion’, which specializes in creating connections between different actors to help construct the innovation ecosystem. Finally, our results underline the centrality of entrepreneurial ecosystem roles – ‘entrepreneur’, ‘sponsor’, and ‘regulator’ – in facilitating and supporting the creation of entrepreneurial ventures about which the innovation ecosystem will develop.

The roles that have emerged from our study of the literature are available for different actors to enact over time. For example, we may anticipate the role of ecosystem leader to be assumed by actors such as universities or governments in the very early period of ecosystem genesis, when much uncertainty and technological infancy can discourage investments by private entities. In time, as commercialization prospects improve, ecosystem leadership can shift to another actor. Dedehayir and Seppänen (2015) illustrate this shift in their analysis of the copper production ecosystem, which experienced a transition in ecosystem leadership from universities in the early period to copper production firms later on. Given that actors are likely to make their strategic investments at different times during ecosystem birth, and expect returns for their investments as well, the timing and the conditions under which such transitions are likely to occur form a very

fruitful path for future research. The literature review depicts a rather linear, structured and formulated process, we additionally propose that different actors can occupy the same role simultaneously. This is most famously illustrated by Wintel's (Microsoft and Intel) leadership of the relatively early period of the PC ecosystem's evolution (Cusumano and Gawer, 2002). Although much of the literature suggests a single actor's occupation of the ecosystem leader role, we believe that dual or multiple leadership schemes may form an important component of ecosystem birth and therefore deserves further investigation. Furthermore, actors are likely to enter the innovation ecosystem at various times across the birth phase, and also assume a sequence of different roles as the genesis process unfolds. The entrance and exit of actors to and from the ecosystem, as well as their transition between different roles, informs the dynamics of ecosystem birth. Whilst our present contribution has not aimed to reveal this dynamics, we believe that future research can build on the role typology we have proposed to shed further light on ecosystem change, which has implications for numerous actors that decide on which roles to undertake, when, and with what level of resource investment.

Ecosystem birth is likely to be more fuzzy, iterative, and chaotic than later phases of the ecosystem lifecycle, in a similar manner to the fuzzy front end of NPD (new product development) processes (e.g. Kim and Wilemon, 2002). The fuzzy front end of a company's internal NPD process is characterized by unstructured search for ideas with, in many cases, minimal planning and control surrounded by uncertainty (e.g. Koen, et al., 2001). Koen et al. (2001) also elaborate the purpose of the fuzzy front end (or in their definition as the New Concept Development Model) as opportunity identification and analysis with idea genesis and selection leading to concept and technology development. The emergence of an ecosystem is similarly uncertain given the search for value proposition and delivery involving multiple actors

with differing roles. Moreover, while the front end of NPD often focuses on moving an innovation from discovery to commercialization within a single organization, the birth phase of the innovation ecosystem essentially deals with the same phenomenon, albeit in the context of a network of organizations. By addressing ecosystem genesis, we therefore contribute towards a more comprehensive understanding of networked NPD involving multiple agents and a need to orchestrate resource allocation (either in a planned or unplanned, emergent manner). Our work particularly relates to and extends Markham et al.'s (2010) analysis of informal roles (champions, sponsors, and gatekeepers) that come to prominence in the front end of innovation within a single organization. Nevertheless, our work focuses only on role identification and as a result offers the first step in expanding our conceptualization of roles in the grander, ecosystem setting. Following Markham et al. (2010), we endorse a couple of important ways in which future research can work towards this objective. The first relates to the dynamic interdependence between roles, whereby, roles would be expected to take center stage at different times during ecosystem genesis. Although we have made tentative propositions in this paper, extensions of our study (e.g. through qualitative studies) could seek patterns in which particular roles acquire significance in guiding an innovation from an initial discovery to a commercializable product or service. Secondly, and extrapolating the valley-of-death hypothesis to the ecosystem context, future empirical work could seek to find key roles that crucially act as bridges that connect the discovery and commercialization stages of ecosystem genesis. Our review of the literature tentatively points towards the activities of the champion, together with the ecosystem leader, in circumnavigating this volatile period, and we encourage empirical studies to verify this proposition. This agenda could lead to the definition and characterization of the New Ecosystem

Development process model extending the traditional formulations of NPD process models (e.g. Cooper, 2001), underlining the roles that are pertinent to successful ecosystems genesis.

Our paper has implications for a range of stakeholders, including university, industry, and government partners, which are ultimately concerned with the formation of innovation ecosystems to enhance economic welfare. The typology of roles we have proposed present positions in the social network that these actors can choose to occupy. We expect that these role-based decisions will be governed by the level of fitness between the core competences of the actors and the set of activities that define the roles.

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