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Modeling the ecosystem: a meta-synthesis of ecosystem and related literatures

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Abstract

The "ecosystem" metaphor has been gaining increasing currency in management research; however there is only limited recognition and integration of other similar management constructs and underlying theory. We conduct a systematic review of the ecosystem and related literature, defining an ecosystem as a network of interconnected organizations, organized around a focal firm or platform, which incorporates both production and use side participants. We suggest three interdependent characteristics that provide the boundaries of the ecosystem construct - value logic, participant symbiosis and institutional stability - and outline the interrelationships between them. Utilizing these characteristics, we propose the "ecosystem model" as a practitioner tool, analogous to the business model, which describes the rationale of how an ecosystem creates, delivers and captures value. We conclude by identifying emerging trends and areas for future research.

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MODELING THE ECOSYSTEM: A META-SYNTHESIS OF ECOSYSTEM AND RELATED LITERATURES

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ABSTRACT

The 'ecosystem' metaphor has been gaining increasing currency in management research; however there is only limited recognition and integration of other similar management constructs and underlying theory. We conduct a systematic review of the ecosystem and related literature, defining an ecosystem as a network of interconnected organizations, organized around a focal firm or platform, which incorporates both production and use side participants. We suggest three interdependent characteristics that provide the boundaries of the ecosystem construct – value logic, participant symbiosis and institutional stability – and outline the interrelationships between them. Utilizing these characteristics, we propose the 'ecosystem model' as a practitioner tool, analogous to the business model, which describes the rationale of how an ecosystem creates, delivers and captures value. We conclude by identifying emerging trends and areas for future research.

INTRODUCTION

The ecosystem metaphor has been increasingly used in management research and practice. For instance, it has recently been argued that the focus of marketing and strategy must be to shape the ecosystem in which the firm resides (Singer, 2006). This rather versatile and loosely defined term was first introduced in practitioner literature in the mid-1990s (Moore, 1993), and subsequently the metaphor has been increasingly adopted also in research journals such as the Strategic Management Journal (Adner & Kapoor, 2010; Pierce, 2009; Teece, 2007). The attractiveness of this metaphor rests on its ability to evoke and highlight interdependencies between organizations and to provide a fresh way to think about specialization, co-evolution, and co-creation of value (Adner & Kapoor, 2010; Frels, Shervani, & Srivastava, 2003). However, useful as they may be, powerful analogies also have limits, and sometimes the strong mental images evoked by strong analogies may even obscure important differences between a given phenomenon and the analogy used to make sense of it. Importantly, powerful and attractive analogies do not negate the need of coherent theory that has been explicitly developed to describe the phenomenon of interest and not some analogous phenomenon.

In management research, the term 'ecosystem' is usually used to refer to a network of interconnected organizations that are linked to or operate around a focal firm or a platform (Iansiti & Levien, 2004b; Moore, 1993; Teece, 2007). The difference with other network constructs in management research is that this network covers both production side and use side participants, including complementary asset providers and customers. Hence we define an ecosystem as: *a network of interconnected organizations, organized around a focal firm or a platform and incorporating both production and use side participants*. This definition incorporates a central focus around which production and use side participants are organized, either a focal firm in the locality (Adner & Kapoor, 2010; Anderson, Hakansson, & Johanson, 1994; Teece, 2007), a central hub firm (Iansiti & Levien, 2004b; Jarillo, 1988; Möller, Rajala, & Svahn, 2005), or a platform (Cusumano & Gawer, 2002). The explicit inclusion of use side participants differentiates the ecosystem construct from other networks in management literature, such as clusters, innovation networks, industry networks, which are focused on the production side, and user networks, which focus on the use side. On the other hand,

ecosystems research can be considered part of a wider and heterogeneous body of network literature in management research. In this literature, the inclusion of use side participants is not a unique characteristic of ecosystems, as use-side participants are also included in strategic networks (Gulati, Nohria, & Zaheer, 2000; Jarillo, 1988), business networks (Anderson et al., 1994; Möller & Svahn, 2006), value nets (Nalebuff & Brandenburger, 1996), value networks (Christensen & Rosenbloom, 1995; Stabell & Fjeldstad, 1998) and value constellations (Normann & Ramirez, 1993).

At issue is whether the notion of ecosystems can provide a coherent focus for a distinctive subset of network research, and if yes, what the theoretical underpinnings, pertinent themes, and salient research questions of this research should be. In spite of the proliferation of research on 'ecosystems', or perhaps because of it, these issues are far from clear. This is an important gap, since without coherent theoretical underpinnings, cumulativeness suffers, and ecosystem research risks not fully delivering on its obvious potential. It is our objective in this study to identify and explore possible theoretical underpinnings of the ecosystem phenomenon and to propose a unifying theoretical framework for research on ecosystems. We do this by conducting a systematic literature review of the ecosystem literature in order to uncover the underlying theoretical logics. In so doing we are able to solidify the theoretical grounding of ecosystem research (Tranfield, Denyer, & Smart, 2003).

We first contribute by suggesting three defining ecosystem characteristics. These three characteristics not only provide a framework to better understand ecosystems, but also aid in cumulativeness and relevance by defining key dimensions and boundary conditions. The *value logic* characteristic takes notions of value co-creation and appropriation and develops these to include the sources of value. In particular, efficiency, innovation and flexibility benefits are recognized as the sources of value in ecosystem contexts. The *participant symbiosis* characteristic builds upon notions of co-evolution and symbiosis. Participant co-specialization, complementarity and co-evolution together enable symbiosis and the co-creation and appropriation of value. The *institutional stability* characteristic develops the importance of the locus of coordination, legitimacy and trust, and governance mechanisms. These are demonstrated as vital for the creation, development, health,

stability and maintenance of an ecosystem. These three characteristics provide the basis for a more systematic and coherent understanding of an ecosystem construct.

We also contribute by proposing the 'ecosystem model' at the network level as analogous to the 'business model' at the firm level. By suggesting the notion of the ecosystem model, we aim to provide a lens for which an ecosystem participant can consider the *ecosystem as a whole*, as distinct to the business model which provides a lens at their particular firm level. Put differently, in the spirit of Osterwalder and Pigneur (2010), an ecosystem model is a description of the rationale of how an ecosystem creates, delivers and captures value. In this way the ecosystem model is an application of the three characteristics of ecosystem construct to management practice. We illustrate the ecosystem model through a consideration of three common ecosystem variants within the literature, the business ecosystem, the innovation ecosystem and the technology ecosystem.

To develop this understanding of the three interdependent characteristics of an ecosystem construct, this paper builds on a systematic review and a critical meta-synthesis of ecosystem and related research in management. We begin by describing the review methodology and proceed to describing the three key ecosystem characteristics – the value logic, participant symbiosis and institutional stability – which we suggest as the boundaries of an ecosystem construct. We then propose the 'ecosystem model'. We conclude by drawing implications for theory and practice, as well as identifying emerging trends and areas for future research.

METHOD

We adopt an approach similar to the systematic reviews in medicine, where systematic reviews are used to consolidate results of major studies on a particular topic (Higgins & Green, 2006; Tranfield et al., 2003). However, instead of a meta-analysis, for which a large number of relatively coherent empirical studies are needed, we take a meta-synthesis approach. This approach takes mostly qualitative literature that is not narrowly focused on a well-defined construct and synthesizes higher-order theoretical constructs. In doing so we can take into account important similarities and differences between the papers (Sandelowski, Doherty, & Emden, 1997; Tranfield et al., 2003).

We first searched the Web of Science ISI Social Sciences Index database for articles that had 'ecosystem*' in the topic field (n = 921). ISI is generally considered the most comprehensive database for scholarly work and includes thousands of journals. Although not all journals are included, ISI typically includes the most prominent journals. As the term 'ecosystem' has a number of common English meanings, there was substantial noise in the search results. It would have been possible to use other search terms to refine the search, however this approach was discounted as using any further search terms would risk biasing the results to academic areas that we are particularly familiar with (Schildt, Zahra, & Sillanpaa, 2006). It would also have been possible to refine the search by restricting the results to key journals in which ecosystem-related articles could exist as is common in management literature reviews (Brown & Eisenhardt, 1995). However given the relatively small amount of papers identified, it was preferred to read the abstract of each article and apply exclusion criteria. The first set of exclusion criteria removed those papers that used the term in an environmental science usage (n = 830), while the second based on identifying single usage, multiple uses without elaboration or which did not refer to organizational phenomena (n = 59). To ensure that only management literature were included, a final filter compared the data set with the journals listed by the Academic Journal Quality Guide of the Association of Business Schools (n = 6). The Academic Journal Quality Guide provides a guide to the range, subject matter, and relative quality of the journals in which business and management academics publish (Harvey, Kelly, Morris, & Rowlinson, 2010). The individual papers for the remaining documents were then downloaded (n = 26).

Each downloaded paper was read and coded to identify definitions, academic tradition, type of research and implied theory (Dahlander & Gann, 2010; Tranfield et al., 2003). From this basis we snowballed the literature collation, identifying similar constructs referred within these papers and cascading this approach to the identified papers. We ceased snowballing when we had reached saturation (Yin, 1984), in that no further management constructs could be identified from the collection of papers. This lead to the identification of a further 850 papers which cover a wide range of management constructs. These were found on ISI using the following search criteria: 'value constellation*' (n = 10), 'value network*' (n = 54), 'value net*' (n = 18), 'value web*' (n = 5),

‘business network*’ (n = 289), ‘strategic network*’ (n = 59), ‘innovation network*’ (n = 132), ‘network* organization*’ (n = 97), ‘virtual organization*’ (n = 95), ‘co-opetit*’ (n = 32), ‘business web*’ (n = 45), ‘enterprise network*’ (n = 12), and ‘network* corporation*’ (n = 2). We also searched for alternative spellings, such as “organisation”. To ensure consistency with the ecosystem papers, the abstract of each was read and exclusion criteria applied. The first filter excluded those which where grammatical coincidences, a single usage, multiple uses without elaboration or which did not refer to organizational phenomena (n = 603), while a second filter excluded those usages that did not include both production and consumption side participants in the network (n = 177). In this case a further filter was not required as the search terms were not words with common or scientific meanings. Similarly, to ensure that only management literature were included, a final filter compared the data set with the journals listed by the Academic Journal Quality Guide of the Association of Business Schools (n = 22). The individual papers for the remaining documents were then downloaded (n = 70). Again, each downloaded paper was read and coded to identify definitions, academic tradition, type of research, and implied theory.

In order to synthesize the higher order constructs, we then analyzed all papers (n = 96) as a single corpus. We reviewed each paper utilizing a grounded theory approach (Corbin & Strauss, 1990; Glaser & Strauss, 1968), and coded each paper systematically identifying key concepts. Through successive coding and the development of higher order codes, we were able to identify the commonalities and by extension the key elements that constitute the ecosystem construct. This methodology also enabled us to track inter-relationships between each of the constructs and concepts. In addition we conducted a co-citation analysis on the whole corpus as well as the individual management constructs. This co-citation analysis identified the key referenced articles (Schildt & Mattsson, 2006; Schildt et al., 2006), providing further a mechanism to highlight key concepts, theoretical bases, and invisible colleges (Gmur, 2003; Small, 1973). We produced tables and graphs of the cited papers, identifying trends, inter-relationships, patterns of co-authorship, and the key underlying theoretical influences, theories and literature.

THE ECOSYSTEM CONSTRUCT

From our meta-synthesis it is possible to discern three independent yet interdependent commonalities which provide the contours of the ecosystem construct. Figure 1 details the interdependent common characteristics.

[Insert Figure 1 around here]

The first common characteristic is the importance of the logic of value, particularly the sources of value, value creation and value appropriation. The second common characteristic is the symbiotic relations of the participants in an ecosystem, as each participant not only provides specialized and complementary inputs for the creation of value in the ecosystem but also co-evolve to maintain the stability and health of the ecosystem. A final common characteristic is the institutional stability within an ecosystem, where there is an established locus of coordination that is viewed as legitimate and having a good reputation by the other ecosystem participants. The locus of coordination provides the structure for the operation of the specific governance mechanisms that coordinate the ecosystem. We now discuss each in turn.

Value logic

The first common characteristic within the value scope is the value logic, where value co-creation, the sources of value, and value appropriation are vital to understanding the boundaries of the construct. A key element of the value logic is value co-creation, where customer value is generated from the interaction of ecosystem participants in co-production. A second key element are the sources of value, such as flexibility, innovation, and efficiency benefits, as differing sources of value will lead to differing ecosystem dynamics. An important further element is the capture of value, as the failure for the value to be shared across the participants will result in the poor ecosystem performance.

In ecosystems contexts value is co-created through the interaction and combination of the participants in the ecosystem (Adner & Kapoor, 2010; Anderson et al., 1994; Christensen & Rosenbloom, 1995; Iansiti & Levien, 2004b; Normann & Ramirez, 1993). Value is created through a collective, networked and reciprocal process of co-production, as distinct to a linear fashion as implied by a value chain. This dynamic flexible network creates value for all of its participants as

these participants operate within a collaborative network which combines each company's core competences (Bovet & Martha, 2000). In particular, the ecosystem creates value for a participant when that participant is not capable to launch the product through its own competences and requires a network of supporting organizations (Lin, Wang, & Yu, 2010). However the presence of an ecosystem or network does not necessarily lead to value creation, only to opportunities to do so, and it is how the participants behave and pursues opportunities with other participants that leads to success (Hughes, Ireland, & Morgan, 2007). Hence value co-creation is driven by both inter and intra-firm relationships (Windahl & Lakemond, 2006), with the actions of individual firms impacting the overall value created. For instance, firms need to balance between broadening their number of relationships and maintaining those existing relationships, as these have an interlinked effect on firm performance (Wincent, Anokhin, Ortqvist, & Autio, 2010).Similarly, ecosystems can also be a constraint as they may lock firms into unproductive relationships or preclude partnering with other viable firms (Gulati et al., 2000).

The sources of value are vital to understanding the logic of value and value co-creation within ecosystem contexts. A first source of value is flexibility, in that the ecosystem is able to respond to systemic challenges and opportunities (Iansiti & Levien, 2004b). Flexibility is realized through the co-specialization and complementarity of ecosystem participants. In this way, flexibility creates value for all ecosystem participants because these participants operate within a collaborative network which combines each company's core competences (Bovet & Martha, 2000). The flexibility benefits realized through ecosystems mean that there is faster time to market, continuous awareness of changing conditions and crucially, the ability to identify and remove partners (Iyer & Davenport, 2008). Similarly, flexibility enables group of collaborators to exploit a specific opportunity (Bovet & Martha, 2000). At the firm level, ecosystems are also a source of flexible opportunity as they potentially allow access to information, resources, markets, and technologies (Nosella & Petroni, 2007). In addition, this flexibility allows the sharing risks and outsourcing value chain stages and organizational functions (Gulati et al., 2000; Rabinovich, Knemeyer, & Mayer, 2007).

A second source of value is efficiency, particularly echoed in transaction cost and transaction exchange perspectives (Williamson, 1975). Efficiency is key for the interlinking of activities and the leveraging of resources (Anderson et al., 1994), and can lead to sustain competitive advantage vis-à-vis competitors outside the network (Jarillo, 1988). If a firm is able to obtain an arrangement whereby it farms out activities to the most efficient supplier and keeps for itself the activity in which it has comparative advantage, this can lower transaction costs (Jarillo, 1988). Similarly this logic leads to the realization of both scale and scope efficiencies (Gulati et al., 2000; Iyer & Davenport, 2008; Rabinovich et al., 2007). The scale and composition of the network, as well as the capacity utilization and linkages between participants also leads to increased efficiency (Stabell & Fjeldstad, 1998).

Value can also be found in innovation benefits, such as through increased innovation generation and improved technological transfer opportunities (Nosella & Petroni, 2007). This source of value considers innovation as a source of value creation, as novel combinations of resources and services lead to new products (Schumpeter, 1934). Implicitly assumed in this stream is the ability of the innovator to appropriate value in the ecosystem (Teece, 1986). Innovation acts as a source of value as it is distributed across different participants in the ecosystem, leading to scalability, an accelerated development lifecycle, and third party support (Iyer & Davenport, 2008). This drives not only individual innovation, but also industry wide innovation (Cusumano & Gawer, 2002). For instance, the interaction of participants in ecosystems has effects on licensing decisions such as patent protection as well as the operation of technology markets (Lichtenthaler, 2010). Innovations within ecosystems are also generated more quickly and efficiently due to knowledge co-evolution (Fang & Wu, 2006) and through participant learning (Adner & Kapoor, 2010; Doz & Hamel, 1998; Gulati et al., 2000; Rabinovich et al., 2007). However to achieve these innovation benefits participants need to invest in creating new knowledge and exploring alternative architectures, so that they can connect disparate elements of that knowledge together in cohesive ways (Chesbrough & Appleyard, 2007).

A further benefit that accrues to ecosystems are network externalities, as standards and lock-in can lead to value creation (Katz & Shapiro, 1985, 1986). In ecosystems where there is a mediating technology, value creation is driven by both direct and indirect positive network demand side

externalities underpinned by standards (Stabell & Fjeldstad, 1998). Similarly, the value of participants innovations can increase dramatically as more users adopt ecosystem products and its complements (Gawer & Cusumano, 2008). This is due to the fact that ecosystems are often associated within multisided markets (Funk, 2009; Gawer, 2009; Thomas, Autio, & Gann, 2012) where winner take all dynamics come into play (Eisenmann, Parker, & Van Alstyne, 2006). Similarly in a healthy ecosystem network effects can further perpetuate the adoption of open architecture.(Chesbrough & Appleyard, 2007).

Finally, value appropriation within ecosystems is an important element of the ecosystem, as each participant must capture a sufficient portion of the overall value to justify its participation (Iansiti & Levien, 2004b; Lin et al., 2010). One mechanism to ensure fair value appropriation is through trust and through valuing the relationship in itself (Gulati et al., 2000; Jarillo, 1988). This trust sometimes resides in central hub firms, called keystone firms, which act as a coordinator ensuring both the creation and sharing of value (Iansiti & Levien, 2004a, b). However if fair value appropriation is not achieved within an ecosystem, dominating firms can drain value from the ecosystem and eventually destroy them by leaving too little value to support it (Cusumano & Gawer, 2002; Iansiti & Levien, 2004a, b). Interestingly, although much of the literature discusses the importance of fair value appropriation within ecosystem contexts, very little of the literature systematically develops the concept of fair value capture in either empirical or theoretical manner.

Summarizing, the value logic, namely the sources of value as well as value co-creation and capture, are key to understanding the boundaries of the ecosystem construct. Value in ecosystems is co-created by network participants in a non-linear systemic manner, where value is driven from efficiency, flexibility, externality and innovation benefits.

Participant symbiosis

A second common characteristic is the symbiosis between the participants in an ecosystem. Participant symbiosis between the participants is driven by three elements. The first is that the participants are specialized, in that each provides a particular input that makes up the system. A second element is that each participant is complementary, in that they are not only heterogeneously

specialized and evolve together, but also add to the value creation through synergistic, cumulative interaction. A final element is that the participants co-evolve, in that they grow and develop in ways to maintain the stability of the ecosystem.

Specialization is a feature of modern economic organization (Nelson & Winter, 1982; Smith, 1994; Stigler, 1951) and emanates from the need to provide specialized inputs to support the ecosystem (Cusumano & Gawer, 2002). For instance, in telecommunications contexts, specialization often consists of new technology, customer relationship management and infrastructure management (Li & Whalley, 2002). Within ecosystems co-specialization drives the performance of the ecosystem (Christensen & Rosenbloom, 1995; Iansiti & Levien, 2004b; Jarillo, 1988; Normann & Ramirez, 1993). This participant specialization enables the lowering of the final total cost and leads to the economically feasibility of the ecosystem (Jarillo, 1988). From a resource perspective, specialization enables performance as each participant contributes only what it regards as its core competencies (Christopher & Gaudenzi, 2009), and this collaboration between participants and their core capabilities drives value creation ability of the network (Bovet & Martha, 2000).

Complementariness, or the synergistic and cumulative interaction between participants, is an important dimension on the symbiosis that exists between participants. As participants are heterogeneous, the creation of synergies is not achievable without complementarity (Iansiti & Levien, 2004b; Moore, 1993) and where each participant is individually significant and interdependent on the other (Mouzas & Ford, 2009). Complementariness is not only expressed through the functional characteristics of each participant, but also through their obligations to the ecosystem and the product or service co-production lifecycle (Agerfalk & Fitzgerald, 2008). The complementariness and interdependence among participants is often driven by customer dynamics, competitive dynamics and technology dynamics (Pagani & Fine, 2008). Without complementariness, the co-specialization of the participants is not sufficient for the ongoing creation and appropriation of value in the ecosystem. This is due to the fact that complementariness ensures that the competences and capabilities of the individual participants are cumulative and synergistic. Hence the complementariness between the

participants provides the substance from which value is co-created (Adner & Kapoor, 2010; Gulati et al., 2000; Iansiti & Levien, 2004b).

Symbiosis is also driven by co-evolution, as the participants need to develop over time sympathetically with the other participants in order to maintain stability and health of the ecosystem in the face of change. Co-evolution is the corollary of both co-specialization and complementariness in that ecosystem participants necessarily provide the co-specialized and complementary inputs that enable the co-creation of value. As market and technological conditions change, in order to continue the co-creation of value, they need to change in harmony with the changing ecosystem. Thus when technological change renders obsolete the capabilities of other ecosystem participants, in that they were not able to co-evolve, the other non-affected participants also have a performance decrease (Afuah, 2000). Similarly, the timing of a technology entry is important in maintaining ecosystem stability so that the other participant firms have an opportunity to evolve in response (Afuah, 2004). In order to maintain specialization and complementarity in the face of ecosystem hazards, only some complementary firms possess the knowledge or related experience necessary to adapt to this changing ecosystem, meaning that those that do no evolve, perish (Pierce, 2009). Thus in order for the participants to co-evolve, each participant needs to anticipate, exploit, and expeditiously react to the activities of other participants (Pierce, 2009).

Overall, participant characteristics of co-specialization, complementarity and co-evolution are vital to understanding the nature of ecosystems. Together these provide a mechanism which drives value creation, and the nature of their interrelationships determines the stability and health of an ecosystem.

Institutional stability

The third common characteristic is institutional stability. Institutional stability refers to the persistence of the actors that make up the ecosystem and enact its processes, a set of validating organizing principles springing from participant legitimacy, and governance structures by which power and authority are exercised. By introducing institutional theory to the analysis, we are not arguing that an ecosystem should be considered a type of organizational field, as both are nebulous

concepts that are difficult to empirically operationalize. Instead we are suggesting that an ecosystem is analogous to an institutional field in that it has its own institutional actors, logics and governance structures (Scott, 2007). We believe that the introduction of institutional theory into ecosystem analysis provides a useful lens in understanding the organizing principles, rules and norms in ecosystems. In their seminal paper, DiMaggio and Powell (1983) defined an organizational field as "those organizations that, in the aggregate, constitute a recognized area of institutional life: key suppliers, resource and product consumers, regulatory agencies, and other organizations that produce similar services or products" (p 148). The key difference between an organizational field and an ecosystem is that instead of covering participants that produce a similar services or products (or what could be considered a single industry), an ecosystem is a cross industry network of producers of many different types of goods and services that can be combined into different combinations (Iansiti & Levien, 2004b). Building on the analogy, we detail below the elements of institutional stability: a locus of coordination, the existence of legitimacy and reputation, and active governance mechanisms.

The first element of institutional stability is the existence of a locus of coordination, or a central actor that coordinates the ecosystem.[1] These loci of coordination are vital to the health and

[1] Not all of the identified literature proposes the existence of a central coordinating firm, with much of the network structure literature focusing on a focal firm that does not necessarily have a coordinating role. There, the focal firm is not required for coordination purposes but instead is necessary for empirical and methodological reasons, as the research is more interested in the individual dyads and ties than the actual roles of the participants. In addition, empirical ecosystem research has identified network roles other than the hub firm. For instance, in his study of the mobile technology ecosystem, Basole (2009) found that no central firm played a coordinating role. Similarly, in their structural analysis of the software sector, in addition to identifying coordinating hub organizations, Iyer, et al (2006) identified broker organizations that acted as liaisons, representatives, or gatekeepers, and bridging organizations. Thus, there is although there is empirical verification of hub firms in ecosystem contexts, other network roles are also present. Despite these reservations on the role of a coordinating firm, and indications of other roles in the network, the majority of the literature explicitly discuss a central firm that coordinates the ecosystem.

stability of an ecosystem as they drive the collective performance of a network through the enablement of both value creation and sharing (Evans, Hagiu, & Schmalensee, 2006; Gawer & Cusumano, 2002; Iansiti & Levien, 2004b). An ecosystem structure of a locus of coordination and surrounding participating organizations is analogous to the institutional actors whose identities, boundaries and interactions are defined and stabilized by an institutional logic (Scott, 2007). Further, from an institutional perspective, it is further argued that the locus of coordination is required for institutional stability. This is due to the fact that individual participants will have institutional logics that are specific to their specific organizational field, and the locus of coordination is required to maintain the ecosystem institutional logics and governance structures in the face of the individual institutional logics of each of the participants. Furthermore, previous network research indicates that hub organizations naturally emerge in networks, regardless of the nature of the networked system, the participants, or the specific nature of the connections (Barabási, 2002; Barabási & Albert, 1999; Cohen, 2002; Newman, 2001). For instance, research into digital services found that while the rate of addition of digital services was linear, the distribution of complementors to hub firms followed a power law, implying that a small number of hub firms provide basis for majority of complementors (Weiss & Gangadharan, 2010). However, the critical element to the coordination of value creation is the underlying architecture that connects all the participants together, which may reside in a single company, a collection of firms, a consortium, or a not-for-profit (Chesbrough & Appleyard, 2007). More specifically, this underlying architecture may be a ‘platform’ (Cusumano & Gawer, 2002; Iansiti & Levien, 2004b; Jacobides, Knudsen, & Augier, 2006; Teece, 2007). These platforms enable value creation through the provision the services, tools and technologies that other members of the ecosystem use to enhance their own performance (Iansiti & Levien, 2004a, b). The coordinating nature of platforms means that they increase the ease with which nodes can connect to each other and also increase the robustness of the network to environmental shocks (Iansiti & Levien, 2004a).

The second element of institutional stability is the ongoing legitimacy and good reputation within the ecosystem through the legitimacy and reputation of the locus of coordination. Legitimacy and reputation are important has they provide the validity that other organizations seek in their

decision to participate and remain in the ecosystem. However, in this case the analogy is rather loose, as in contrast to the institutional perspective, where legitimacy and reputation are vital to organizational identity and the survival of individual organizational forms within an organizational field (Rao, 1994; Suchman, 1995), for ecosystems the legitimacy and reputation of the hub firm is based upon the operating logic that are key to survival of the ecosystem (Gawer & Cusumano, 2008; Iansiti & Levien, 2004b). Key here is sociopolitical legitimacy, were the participants, key stakeholders, opinion leaders, the state and the public validate the ecosystem and its locus of coordination (Scott, 2007; Suchman, 1995). The ongoing legitimacy and reputation of the ecosystem are based upon the belief that participation in the ecosystem will lead to value creation and value capture for the participant, as well as that the locus of coordination will behave in such a way as to maintain stability. Thus the legitimacy and reputation of the locus of innovation are the bedrock upon which the institutional logics, or the taken-for-granted, resilient rules are that specify the boundaries of the ecosystem, the rules of membership, role identities and the appropriate organizational forms, are built (Friedland & Alford, 1991; Lawrence, 1997; Rao, Monin, & Durand, 2003). As a consequence, the ecosystem and related literature has emphasized the development of trust and commitment as an important component of relationship stability and hence ecosystem success (Hadjikhani & Thilenius, 2009). Similarly, ‘platform leaders’ require legitimacy and good reputations in order to ensure that an ecosystem is greater than the sum of its parts (Cusumano & Gawer, 2002). This recognition of the importance of legitimacy and reputation is also reflected in discussions concerning the importance of actively managing the relationships with other participants (Christopher & Gaudenzi, 2009; Cusumano & Gawer, 2002; Ehret, 2004; Gawer & Cusumano, 2008). More specifically, Geersbro and Ritter (2010) point out that uncertainty, ambiguity and conflict between the hub and the participants can be minimized through reputation and relationship management mechanisms such as risk management, flexibility, information seeking, learning, communication, interpretation and negotiation. In a similar manner, Agerfalk and Fitzgerald (2008) indicate that trust can also be developed within ecosystem environments through complementariness of obligations for co-production, alignment of differing perception of obligation fulfillment, and balancing value creation and community values.

The final element of institutional stability is the existence of governance mechanisms through which the locus of coordination exercises power and authority in the ecosystem. These are important for institutional stability as without rules and norms governing the behavior of the participants in the ecosystem, its robustness and success are threatened. These governance mechanisms are analogous to the institutional conception of institutional governance, in that participants who wish to participate successfully in the ecosystem need to conform to these governance mechanisms (DiMaggio & Powell, 1983). Thus in ecosystems the relationships between the participants are constituted through a system of values, norms, rules and other conventions that are shared by participants that provide the framework for value co-creation and symbiosis (Anderson et al., 1994; Mouzas & Ford, 2009). Platforms provide standards and rules that reduce complexity (Iansiti & Levien, 2004b; Weiss & Gangadharan, 2010) and which also facilitate network relationships (Stabell & Fjeldstad, 1998; Thompson, 1967). Through these rules they are able to maintain their dominance. Similarly Cusumano and Gawer (2002) note that governance mechanisms need to be able to adjust of the locus of innovation in an ecosystem so that the locus of coordination can maintain its hegemony. However in contrast to institutional conceptions of governance, in ecosystems governance can also be effected through the provision of a stable and predictable set of common assets (Iansiti & Levien, 2004b) or through being a fundamental technological element of the ecosystem (Gawer & Cusumano, 2008). Governance in this instance is then through varying the modularity of the product and service (Cusumano & Gawer, 2002; Gawer & Cusumano, 2008; Weiss & Gangadharan, 2010) and the standardization of interfaces (Gawer & Cusumano, 2008; Li, 2009; Tilson & Lyytinen, 2006; Weiss & Gangadharan, 2010).

Summarizing, successful ecosystems require institutional stability in that they need a locus of coordination that enables the value creation and value sharing for all participants in the ecosystem. This locus of coordination, however, requires legitimacy and reputation in order to both attract and retain participants in the ecosystem. In doing so, the legitimacy and reputation of the locus of coordination is also reflected at the ecosystem level. An ecosystem must also have active and

respected governance mechanisms that enable the ongoing coordination and control of the value generation and appropriation.

THE ECOSYSTEM MODEL

We have now suggested three independent yet interrelated characteristics and their constitutive elements as the basis for an ecosystem construct. The constituent elements of these three characteristics also provide the basis for proposing the 'ecosystem model'. An ecosystem model is analogous to that of the business model; however the key difference is that while the business model applies at the level of the focal firm, the ecosystem model applies at the level of the network. Put differently, the notion of the ecosystem model provides a lens for which an ecosystem participant can consider the *ecosystem as a whole*, while the business model provides a lens for their particular organization.

Within the practitioner community the business model has gained widespread use and is generally framed in terms of value (Magretta, 2002; Osterwalder & Pigneur, 2010). For instance, Osterwalder and Pigneur (2010) describe the business model as "the rationale of how an organization creates, delivers and captures value" (p 14). However from the academic perspective, the business model as a construct has been more fragmented. For instance, in their recent systematic review of the business model literature, George and Bock (2011) found that business models have been considered from as varied perspectives as organizational design (Timmers, 1998), the resource based view (Winter & Szulanski, 2001), narrative (Magretta, 2002), innovation (Chesbrough & Rosenbloom, 2002), transactive (Amit & Zott, 2001) and opportunity (Afuah, 2003). However common to these heterogeneous views on ecosystems is the business model as an organizational level construct.

The ecosystem model is a practitioner tool enabling both sensemaking and strategic planning within the ecosystem where their firm operates. This implies that Figure 1 is also a tool that can guide the practitioner, as well as the outline of a more rigorous ecosystem construct. Therefore, in the spirit of Osterwalder and Pigneur (2010), we define the ecosystem model as "*the rationale of how an ecosystem creates, delivers and captures value*". The ecosystem model is an application of the three characteristics of ecosystem construct to management practice, and the value logic, participant

symbiosis and institutional stability characteristics are all embedded within the model. The value logic is fundamental to the ecosystem, as it provides the focus on the activities of the ecosystem. In particular, the sources of value provide insight into value creation within an ecosystem, and by extension the mechanisms by which value is able to be captured. Participant symbiosis is reflected within the ecosystem model as an operationalization of the value logic, and hence is vital to understanding the delivery of value. By providing a tool to understand the interrelationships and dependencies that arise between the participants due to co-specialization, complementarity and co-evolution, participant symbiosis provides insight into how value is delivered within the ecosystem. Institutional stability is important across all elements of the ecosystem model – namely value creation, capture and delivery, as it provides insight into the rules and norms that govern transactions within the ecosystem, as well as the importance of legitimacy and trust in ecosystem stability and operation. The locus of coordination is particularly important as it highlights the source of the rules within the ecosystem, and how value is appropriated.

To illustrate the application of the ecosystem model, we now consider ecosystem variants commonly used within the management literature. There are three dominant ecosystem variants (out of 26 papers identified within the review): the 'business ecosystem' (n = 10), the 'innovation ecosystem' (n = 7), and the 'technology ecosystem' (n = 3). Each of these represents a differing rationale for ecosystem creation, delivery and capture of value. Given this focus on value, differing ecosystem models primarily vary on the value logic, with both participant symbiosis and institutional stability characteristics supporting particular value logics. Figure two below outlines three differing ecosystem models.

[Insert Figure 2 around here]

The *business ecosystem* emphasizes efficiency and flexibility as key sources of value in the ecosystem, where value is co-created through scale and scope economies. For the business ecosystem participant symbiosis is driven by the need to create efficiency in production of goods and services and meeting customer needs. Business ecosystems are typified through the work of Moore (1993) and Iansiti and Levien (2004b), who both use the case study of Wal-Mart. For Moore (1993), the locus of

coordination is the firm, while for Iansiti and Levien (2004b), although arguing for firm level strategies, introduce platform level coordination. In contrast, an *innovation ecosystem* emphasizes innovation and externality benefits as the sources of value creation. For innovation ecosystems, participant symbiosis is structured around economies of complementarity and innovation, leading to superior performance for the participants within the ecosystem. Institutional stability is driven through a firm level locus of coordination. Innovation ecosystems are well illustrated through the work of Adner and Kapoor (2010) in their study of the semi-conductor lithography industry. Finally, a *technology ecosystem*, also called an industry ecosystem, also emphasizes innovation and externality benefits as the primary sources of value, with the participants in symbiosis to drive economies of complementarity and innovation. However, in distinction to the innovation ecosystem, the technology ecosystem has the platform as the locus of coordination. An example of this is Cusumano and Gawer (2002), who build up a series of strategies for the platform leader, yet explicitly refer to the platform as the locus of coordination. In their case studies of Intel, Microsoft and Cisco, it is the value that stems from the network externalities and distributed innovation that drives value creation.

Summarizing, we have proposed the ecosystem model as a network level analogue to the business model for the firm. An ecosystem model is the rationale of how an ecosystem creates, delivers and captures value, and is a tool that applies the three characteristics of the ecosystem construct. To demonstrate its usefulness we have argued that the three main variants of ecosystems in the literature – business ecosystems, innovation ecosystems, and technology ecosystems – are differing ecosystem models with differing value logics and loci of coordination. It is hoped that in the same manner that the business model provides a useful lens for firms to focus on the things that matter for their business, the ecosystem model provides a useful lens for ecosystem participants to focus on the things that matter for their ecosystem.

FUTURE DIRECTIONS

Overall, this review highlights the potential depth and research scope of the ecosystem construct, as well as some strengths, weaknesses, and trends. On the basis of this review, a number of trends are apparent in the ecosystems and related literature. Firstly, there has been an incremental

increase in the scope of the ecosystem construct. From the initial identification of the suppliers, complementors and customers, the ecosystem now is considered to include competitors, universities, regulators, judiciary and standard setting bodies (Teece, 2007). Indeed it has been proposed as an alternative to the external environment for understanding dynamic capabilities (Teece, 2007). Second, the trend in ecosystem research presents the challenge of leveraging institutional, resource dependence, and sociological theories more explicitly for conceptual development, all of which have been identified within this review. Although we have begun to introduce institutional literature through our inclusion of institutional stability, ecosystem research could gain significantly from a more explicit integration of sociological and institutional literatures.

A limitation of this review is the snowball technique utilized to identify the related literature. In particular, the review of the related literature was restricted to that which only included both production and use side participants. Although this was necessary to constrain the number of identified papers to manageable levels, there are other management constructs that either solely look at production or use side have been excluded that would shed further light on ecosystems. For instance, in terms of production side only networks, the literature related to innovation networks and clusters would potentially provide more theoretical depth. Similarly research into use side networks of users would also be valuable, such as the work of Von Hippel (2007). Future research here is left to others. A second limitation is that this review has focused on ecosystems within management and in management research. Broadening the scope of the review to expressly include other disciplines would deepen our understanding. A third limitation is our focus on the ecosystem level of analysis. In developing the analysis of the theoretical underpinnings and boundaries to ecosystems it is apparent that multiple levels of analysis come into play. This paper only covers these multiple levels lightly, focusing more on the ecosystem level for its analysis. However we have alluded to alliance, dyad, firm and platform levels of analysis. We believe further research and analytical work may be fruitful through the perspectives of different analytical lenses.

Limitations aside, a number of areas warrant further research in their own right. Despite the importance of the logic of value, the majority of the literature to date has not directly considered value

creation and appropriation, or the more nuanced perspective of fair value appropriation. Although Adner and Kapoor (2010) have explicitly and empirically linked value creation and value capture within ecosystem contexts, this is perhaps the only paper to date to have done so. Given the importance of the value logic, and in particular the co-creation and appropriation of value, a more coherent and detailed formulation similar to the value creation logics of Doz and Hamel (1998) for alliance contexts will aid both academic and practitioner understanding.

A second area for further research is the continued development of both the ecosystem construct and ecosystem model themselves. For the ecosystem construct, effort needs to be focused on operationalizing the elements of each of the characteristics the construct. Although we have alluded to potential operationalization through our identification of the related empirical work, this needs to be made explicit for fruitful empirical research. For the ecosystem model, the implications of the interrelationships of the value logic, participant symbiosis and institutional stability characteristics need to be further developed to provide more practitioner insight.

There is also a need for a detailed understanding of the processes by which ecosystems are created. At present, the processes of ecosystem creation have been considered variously from both lifecycle and teleological perspectives (Van De Ven & Poole, 1995). For instance, a lifecycle approach has been proposed for ecosystem (Moore, 1993), network structure (Larson, 1992), and network management perspectives (Möller & Svahn, 2009). The lifecycle approach considers ecosystem creation as a series of path dependent stages driven by a common underlying process. Conversely teleological perspective has been also proposed for an ecosystem (Gawer & Cusumano, 2008) and network structure (Doz, 1996; Ring & Van De Ven, 1994). In this approach an end state is attained through a repetitive sequence of goal formulation, implementation, evaluation and modification. More recently, an emerging stream of behavioral research has considered simultaneous and interlinked teleological and lifecycle processes (Hallen, 2008; Hallen & Eisenhardt, 2012). However this literature is considered, no model to date comprehensively considers how complementary markets themselves are initially created (with the exception of Santos & Eisenhardt (2009)), nor has closely examined or systematically integrated the underlying processes.

Fourth, there is an emerging stream of literature arguing that strategic networks and ecosystems have become the basis of competition (Gulati et al., 2000; Iansiti & Levien, 2004b; Iyer, Lee, & Venkatraman, 2006; Moore, 1993; Normann & Ramirez, 1993). This view argues that in the information economy, the ecosystem is the new referent for strategy formation as the locus of competition is shifting from the firm to the network, and the coordinating firm has a role to ensure the competitiveness and the response to opportunities and threats (Iyer et al., 2006). An example of this is the current competitive battle between operating systems for smart phones – namely Google Android, Apple iOS, Blackberry RIM and Microsoft Windows Mobile 7. The competition between these smart phone operating systems is not is not simply between Google, Apple, RIM and Microsoft as hub firms, but is also between the participants in their respective ecosystems, and the ecosystems as a whole. However to date the majority of competitive strategy literature is focused at the level of the firm. A systematic examination of network competitive strategies would extend our understanding not only of ecosystems but also of strategic networks and alliances.

CONCLUSION

In conclusion, the term ecosystem has been gaining increasing currency in management research, although it has remained a rather indistinct and vaguely defined construct to date. In this paper we have provided a working definition of an ecosystem, increased theoretical depth through a snowball identification of other pertinent related streams of literature, sketched out the defining characteristics of the ecosystem construct, and proposed the ecosystem model. This review is just the beginning, as there is much that still needs to be done if we are to both understand networked phenomena better and to use the ecosystem construct in a more meaningful way. We hope that we have provided a more coherent means of understanding ecosystems, and that this paper will inspire researchers to continue to develop the construct into the future.

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FIGURE 1 – Ecosystem characteristics

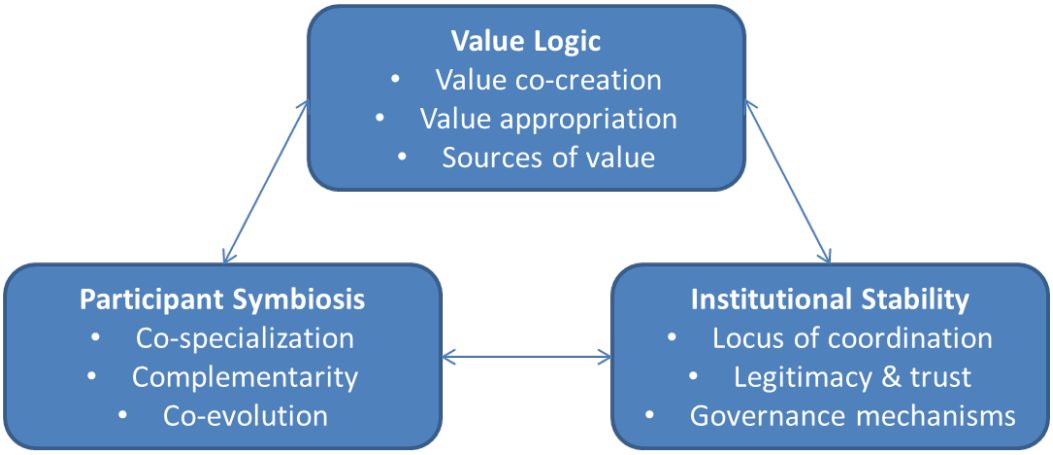

FIGURE 2 – Differing ecosystem models