

Spatial Health and Life Sciences Business Ecosystems: Research Frame

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Industry competition is moving from the company-level towards business ecosystems, where organizations must develop mutually beneficial relationships with each other. This paper studies business ecosystem phenomena, focusing especially on the spatial (geographical) context within the health and life sciences industry. In addition, business ecosystem evolution and change dynamics are addressed. This study is literature-based; the findings and analysis provide a research frame for forthcoming empirical studies. Despite increasing attention, business ecosystem literature is still relatively immature, and previous studies have mostly focused on software and the information technology (IT) industries. Hence, this paper provides new insights into the business ecosystem concept in a novel context.

Key words: business ecosystem, health and life sciences, innovation, spatial context

Introduction

Developed countries seek new growth due to the erosion of traditional industrial clusters and because they are faced with knowledge-based competition from a number of rapidly developing countries. Meanwhile, fast emerging and converging technologies combined with accelerating globalization create a very complex operating environment for companies, policymakers and other stakeholders. Competition is shifting from company and industry levels towards a business ecosystem level.

By *business ecosystem*, we mean constellations of companies and other stakeholders, which are tied together through knowledge flows and shared value creation processes (Iansiti and Levien 2004a; Moore 1993). The preceding concepts, such as *clusters* and *value chains* (e.g., Porter 2000), have received a lot of attention over the years. Yet, in spite of its popularity, the cluster concept has also received increasing criticism that includes, for example, the inability to explain the underlying factors that contribute to certain geographical locations' success (Kim 2013). The business ecosystem concept, in turn, can offer insights into change dynamics and related strategic consequences across industries (Makinen and Dedehayir 2012).

Business ecosystems are typically considered to be global in nature and span various geographical locations. However, as competition between regions and countries increases, it is vital to understand business ecosystem phenomena in a spatial (geographical) context. For this purpose, we apply Carayannis and Campbell's (2009) definition of spatial clusters, which are considered to represent a certain geographic, spatial configuration, tied to a location or a larger region. In this context, proximity is important, as it enhances, for example, knowledge sharing and exchange.

Health care and life sciences involve various public and private actors that are in the business of contributing to people's health. These sciences are considered highly important, having potential for future competitiveness and sustainable growth in many countries. In addition, countries with an ageing population face growing cost pressures in health care, which causes a difficult socio-economic problem in most welfare societies. In addition, an increasingly uncertain and complex global economy necessitates understanding business ecosystem phenomena beyond the software and information technology (IT) industries, which have been the main research focus in the past. Furthermore, this understanding should cover not only companies, but also public sector actors and their roles and relationships. Our research aims to construct a frame to study the ecosystem phenomenon in the health and life sciences industry in spatial contexts. Accordingly, the research questions are set as follows:

1. What dynamic and evolutionary mechanisms affect business ecosystems?
2. What key conditions enable growth and innovation in spatial business ecosystems?
3. What change drivers and barriers exist in health and life sciences business ecosystems?

The answers lay the ground to study business ecosystems in health and life sciences, as they are further synthesized and constructed into a research frame for further studies. This paper is based on literature search, review, analysis and synthesis, and uses a constructive research approach. The reviewed literature includes concepts and models of business ecosystems, dynamics and evolutionary mechanisms of business ecosystems, and respective drivers and barriers characterizing the ecosystems in the health and life sciences industry.

Business Ecosystems and Spatial Innovation

Scientific literature on business ecosystems is relatively novel. In fact, 95 of 101 documents in the Scopus citation database (accessed 4 April 2014) contained the search term *business ecosystem* in the title, abstract and keywords in the area of business and management, dated since 2007. Correspondingly, the search term *innovation ecosystem* resulted in 51 documents, of which 41 were dated since 2010.

The business ecosystem term was introduced by Moore (1993) and reinvented by Iansiti and Levien (2004a). These seminal works along with Teece (2007), Santos and Eisenhardt (2005), Adner (2006), and Adner and Kapoor (2010) form the most established literature body, followed by a series of empirical and conceptual studies. Naturally, the underlying phenomena of business ecosystems has been studied in more specific domains, such as mobile or digital ecosystems (Basole 2009; Corallo 2007), transportation (Leviäkangas et al. 2014), in restricted research subjects and different network concepts and terminologies, as shown, for example, in Majava, Isoherranen, and Kess (2013). Thus, business ecosystem and innovation ecosystem are becoming established as distinctive terms and concepts in scientific business and management literature.

BUSINESS ECOSYSTEMS: CONCEPT, CHANGE DYNAMICS AND EVOLUTION

A major advantage of the business ecosystem concept over other network frameworks is claimed to be its ability to consider the change dynamics and related strategic consequences, which can be very valuable for the ecosystem members (Makinen and Dedehayir 2012; Moore 1993). Majava, Isoherranen, and Kess (2013) argue that innovation and coevolution are the key sources of change dynamics in the business ecosystem.

The business ecosystem life cycle includes four stages: birth, expansion, leadership and self-renewal or death. Innovations are vital in every lifecycle stage: ecosystem births form around innovations, incremental innovations enable growth, and renewals or deaths are caused by innovations. During the self-renewal stage, dominant companies may try to slow the growth of a new ecosystem or they may attempt to blend innovations into their own ecosystem. A fundamental restructuring may also occur during the self-renewal stage (Moore 1993).

Business ecosystems develop through self-organization, emergence and coevolution (Peltoniemi and Vuori 2004). In business ecosystems, companies develop mutually beneficial relationships with customers, suppliers, and competitors (Iansiti and Levien 2004a). The companies coevolve capabilities around a new innovation: they cooperate and compete to support new products, to satisfy customer needs and, finally, to build succeeding innovations. Other actors adjust to the rules set by the lead actors (also known as keystones or platform leaders) who may change over time. However, the ecosystem community values the leaders that enable the members to move toward a shared future and benefits (Iansiti and Levien 2004a; Moore 1993; Moore 1996). The ecosystem rules result from the coevolution and interactions between the participants. Besides competitive forces, constraints are set by the regulators and legislation, standard-setting bodies, social norms and business ethics (Teece 2007).

Makinen and Dedehayir (2012) argue that keystone firms play a vital role in business ecosystem design compared to its other members, such as supporting niche players and various intermediaries. In addition, the level of control assumed by a keystone is a significant internal factor affecting the ecosystem. External factors affecting the ecosystem, in turn, include changes in the social, economic, technological, and competitive environment. Furthermore, bottlenecks, which constrain value creation, motivate innovation that causes changes in the ecosystem.

The term *business ecosystem* is based on evolutionary biology, which explains why *evolution* and *change dynamics* are often used in this context. According to Encyclopaedia Britannica (2014), evolution is 'a process of change in a certain direction' allowing the original biological term to be applied in practically all contexts studying change. Blijleven et al. (2013) propose an approach where key evolutionary biological concepts are translated to their evolutionary economic equivalents: inheritance equals routines, selection

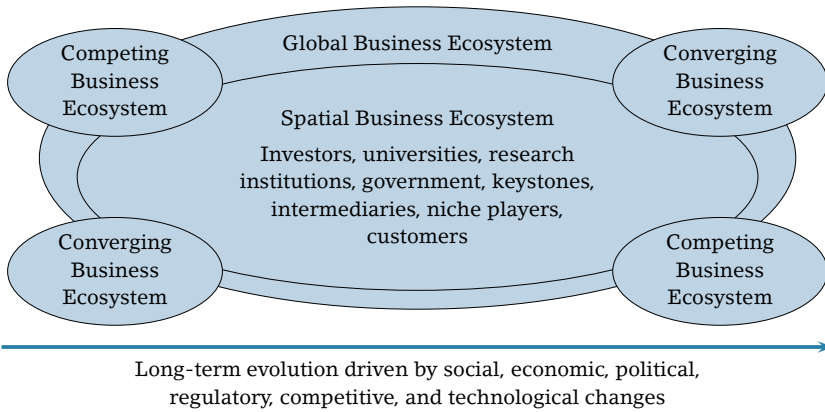


FIGURE 1 Change Dynamics and Evolution within and across Ecosystems

equals competition, and variation (mutation) equals innovation. On the other hand, the term *dynamics* has many definitions depending on the context in which it is used. For example, dynamics can be defined as ‘the branch of mechanics concerned with the motion of bodies under the action of forces’ (www.oxforddictionaries.com).

In this paper, the term *evolution* is used when discussing long-term development in the ecosystems, whereas *dynamics* refers to shorter-term interactions and changes within and between ecosystems. Dynamics in business ecosystems can also be considered from the perspectives of relationships between actors and ecosystems’ influences over others. The boundaries with competing and converging ecosystems may not be clear, and spatial business ecosystems exist within global business ecosystems. This is illustrated in figure 1.

Business ecosystems have been modelled in several studies. Moore (1996) proposed a generic model where actors are classified into three levels based on the extent of business relations: core business, extended network and business ecosystem. Each level contains four different groups of actors; for example, the business ecosystem level includes competing companies and related industries as well as governments and stakeholders such as owners, investors and trade associations (Moore 1996). This generic model serves to explain those who are involved in business, but it does not offer a practical utility to capture the evolution of specific ecosystems or co-evolving relationships between the actors.

Similarly, Basole’s (2009) static analysis of the converging mobile ecosystem visualizes those who are involved and connected to each

other, highlighting the focal companies, but it does not offer insight into the dynamics of ecosystems.

Battistella et al. (2013) developed a more elaborate network analysis and modelling tool to study the static structure of digital imaging ecosystems and proposed foresight methodologies for analysing ecosystem dynamics and evolution. Their contribution and discussion focuses more on tool issues, which can be seen especially in their selection of relationship types between ecosystem actors: no relationship, tangible, intangible, or possible future relationship. Thus, dynamic and co-evolutionary mechanisms between actors are also dismissed in their modelling.

Adner and Kapoor (2010) used a generic schema of an ecosystem to identify four different types of actors: suppliers, focal firm, complementors and customers. The authors address the ecosystem evolution by analysing the effect of external innovations on focal companies and component and complement challenges across nine technology generations in the global semiconductor lithography equipment industry. Modelling global business ecosystems, which can contain thousands of companies and dozens of different 'species,' as seen, for example, in the Microsoft driven ecosystem (Iansiti and Levien 2004b), is needed to visualize inter-firm relations and explain long-term evolution. However, this type of modelling does not reveal change dynamics or co-evolving relationships between the actors. Thus, it is necessary to search for these from more focused fields of literature.

INNOVATION IN BUSINESS ECOSYSTEMS AND SPATIAL CONTEXTS

Innovation is arguably the most important contributor to ecosystem growth. Therefore, different factors accelerating innovation must be understood. These factors can be considered from various perspectives. Makinen and Dedehayir (2012) stress that bottlenecks, which constrain value creation are the major innovation motivators within ecosystems. Bossink (2004), in turn, presents four innovation driver categories in construction networks: environmental pressure, technological capability, knowledge exchange and boundary spanning. Hwang and Horowitz (2012) emphasize talent diversity, trust across social barriers, motivations beyond short-term rationality and social norms that promote rapid collaboration and experimentation. In their view, innovation ecosystems are biological systems; talent, ideas and capital are the nutrients moving through the system. On the other hand, certain geographical regions' innovativeness and success can be viewed from three different perspectives: having uni-

versities as anchors of regional clusters, social networks as an enabling factor and institutional frameworks (Casper 2013).

Innovations require suitable environmental conditions (see Trott 2012). From a spatial viewpoint, these conditions include, for example, adequate basic research, angels willing to invest, talented people and capital (Suh 2010). A triple helix type of collaboration between academia, industry and government is also claimed to accelerate innovations and the creation of new organizations and institutions, such as incubators and venture capitalists (Etkowitz and Leydesdorff 1997; Mok 2012). Thus, many countries and regions are trying to achieve an innovation environment that includes university spin-offs, initiatives for knowledge-based economic development, and boundary spanning and partnerships between companies, government laboratories and academic research groups (Etkowitz and Leydesdorff 2000). These efforts are naturally combined with other policy instruments, such as accessible risk capital and R&D subsidies.

The initiatives to support innovation creation also include legislation changes, financial support, entrepreneurial development and establishing new foundations, organizational forms and programs (Etkowitz and Leydesdorff 2000; Youtie and Shapira 2008). Launonen and Viitanen (2011) also stress the importance of a holistic innovation environment; this is considered to include public policy activities, public-private partnership (PPP)-driven activities, and company-driven activities. The first element contains innovation policy, infrastructure and service structures, and education and training. The second element includes comprehensive R&D systems, cluster policies and programs, test-beds and living labs, and incubation environments. The third element covers start-up creation, SME growth, and dynamic anchor companies that enable access and growth.

SPATIAL BUSINESS ECOSYSTEM EXAMPLE: SAN DIEGO

San Diego has nurtured growing business ecosystems, especially in the life sciences and wireless technologies. Supported by federal government investments in the military and health, the region's focus on R&D began in the 1960s. Universities and research institutions provided the critical mass of R&D capacity, which attracted firms and investors. The local pioneer companies, including Linkabit (wireless), issco (computer graphics), Hybritech (biotechnology) and intermediary organizations, such as CONNECT, have also been vitally important in San Diego's growth. Trust and openness are emphasized in the local business culture (Walshok and Shragge

2014). The region also benefitted from enterprise-friendly policy changes, sound and transparent laws governing real estate, intellectual property, contracts, and corporations, low-enough taxes, low new corporation set-up costs, a network of people with experience in science, technology, business, law, finance, and accounting, and the ability to attract competent immigrants around the world (Hwang and Horowitz 2012).

Walshok and Shragge (2014) argue that five critical factors have enabled San Diego's success: natural advantage of place, values of early settlers, organizing communities for economic promise, the resources and talents the community cultivates, and how citizens define and promote their place. Furthermore, the local civic culture is characterized by risk-orientation, entrepreneurial talent, integrative civic platforms, and multiple gateways to develop ideas and opportunities, and a culture of reinvestment. Kim (2013, 18), in turn, states that the emergence and success of San Diego's biotechnology cluster 'are rooted in a dynamic environment of learning and engagement: (1) a mass of start-ups and small companies, which enabled and, in some respects, forced employees to learn the entire process of the biotechnology business; (2) constant inflows of talent from outside San Diego, which complemented and supplemented the local knowledge stock and practices; and (3) networking and communication opportunities provided by trade associations and research institutions and facilitated by the geographic density of the local environment.' These three factors enhanced learning processes; the emergence of the cluster involved creating and circulating local practices and knowledge and practices (Kim 2013).

Health and Life Sciences

DEFINING HEALTH AND LIFE SCIENCES

Life sciences are 'sciences concerned with the study of living organisms, including biology, botany, zoology, microbiology, physiology, biochemistry, and related subjects' (www.oxforddictionaries.com). Advances in biotechnology and molecular biology have resulted in increasing specializations and interdisciplinary fields in the life sciences. For instance, biotechnology has its roots in 6000 BC when Sumerians and Babylonians started fermenting a kind of beer; since the twentieth century, biotechnology has begun to provide various new applications in the food, chemical, pharmaceutical, and energy fields (Kenney 1986). Health sciences, in turn, can be considered a branch of the life sciences that covers all areas of medicine and med-

ical sciences and contains several sub-disciplines that apply science to health.

Rising health care costs are a major issue in many countries. For example, EU health care spending ranges between 5 and 11% of the regional GDP, while in the US, the corresponding figure is approximately 16% (Blank, Frank, and Karopka 2013; Herzlinger 2006). Increasing costs, demographic changes, and the fact that the health care industry can greatly benefit from advances in the life sciences have resulted in a growing interest in increasing cooperation between the different sectors in the health and life sciences. Furthermore, Blank, Frank, and Karopka (2013) argue that a paradigm shift has occurred: health care is no longer viewed as a financial burden but as a competitive and knowledge-based health economy driver. Recent developments, such as the founding of the European Connected Health Alliance (<http://www.echalliance.com>) and Wireless-Life Sciences Alliance (<http://wirelesslifesciences.org>), showcase the convergence of health and life sciences with other industries; particularly, IT is considered a key innovation driver (Omachonu and Einspruch 2010).

Considering the aforementioned and the complexity and fragmentation of health care systems and markets (Blank, Frank, and Karopka 2013), it is difficult to set exact boundaries for the health and life sciences ecosystem. Health care-related organizations also serve many purposes including prevention, diagnosis, treatment, education, research and outreach (Omachonu and Einspruch 2010). Thus, our definition of the health and life sciences ecosystem includes all public and private actors that are in the business of contributing to human health. These include various companies offering products and services related to, for example, biotechnology, biomedicine, diagnostics, pharmaceuticals, medical devices, health care provision, supporting services, health care IT, connected and wireless health, and health tourism. In addition, the ecosystem includes universities, research institutions, and various intermediaries such as innovation catalysers, incubators, trade organizations, angel investors and venture capital firms. The ecosystem complexity is further increased by governmental involvement and adjacent political interests; a recent example is the process of creating and implementing the Affordable Care Act (Obamacare) in the US (Zwelling and Kantarjian 2014). Hence, the obvious conclusion is that the drawing of boundaries of the *health and life sciences ecosystem* is entirely contingent and must be done for each specific objective, case and task.

INNOVATION IN THE HEALTH AND LIFE SCIENCES

Health-related innovations can take place in various ways. Omachonu and Einspruch (2010, 5) define health care innovation as 'the introduction of a new concept, idea, service, process, or product aimed at improving treatment, diagnosis, education, outreach, prevention and research, and with the long term goals of improving quality, safety, outcomes, efficiency and costs.' Herzlinger (2006), in turn, argues that three types of innovations can improve health care and reduce its costs: change the ways consumers buy and use health care, utilize technology to develop new products and treatments or improve care, and generate new business models – especially ones that involve horizontal or vertical integration of separate health care organizations or activities. On the other hand, the latter two, business model and technology design, have also been found to be strongly interrelated in health-related ventures (Lehoux et al. 2014).

Despite the innovation potential and related benefits, innovation in health care is difficult for several reasons. First, a number of powerful stakeholders including health care providers, doctors, patients and regulatory agencies must support the innovation (Herzlinger 2006; Omachonu and Einspruch 2010). Second, research intensiveness, long development and approval cycles, and third-party payment systems, e.g., governments or private insurers, make innovation funding different from most other industries (Herzlinger 2006). Large amounts of capital are required to get the products to market, and angel investors often favour investing in technologies with faster market access, e.g. software or IT. Less capital-intensive development, such as diagnostics or medical devices, is preferred over drug discovery and development (Global Connect 2010). The third major issue involves policy; regulators tend to avoid risks associated with approving new health-related innovations. Fourth, timing investing and adopting new technology is difficult; the new technology typically requires a supporting infrastructure, but one cannot wait too long as competition exists both within and across technologies. For instance, a vaccine can eliminate the demand for certain drugs and treatments.

The fifth key issue is related to customers. Consumers are increasingly aware of the different options available, and they may either embrace or reject innovations. Sixth, increased accountability is required. In addition to regulators' short-term efficacy and safety requirements, health care innovators must simultaneously fulfil long-

term cost effectiveness and safety to consumers and third-party payers (Herzlinger 2006).

Blank, Frank, and Karopka (2013) stress the following health innovation barriers: complexity of the environment and systems, fragmentation and independency of different actors, fragmentation of R&D efforts, inadequate financing, high IPR costs, slow standardization, ineffective user of public procurement, inadequate support for SMEs, and inadequate utilization of health care professionals and their lack of entrepreneurial and commercialization competences.

The funding system also affects innovation incentives. For instance, the US health care system is based on medical insurance companies' coverage (Zwelling and Kantarjian 2014). The Nordic countries and Latvia have implemented state-financed systems giving free health care access to all citizens (Beveridge system), whereas Germany, Poland and Estonia utilize the so-called Bismarck system financed by social security contributions from the insured employees and their employers (Blank, Frank, and Karopka 2013). Herzlinger (2006) argues that the single-payer system may hinder customer-focused and technology-based innovations; the need to control costs results in less spending on seriously ill patients – the target group of most technology-based innovations. This can also be the reason why a large venture-capital community does not exist in Europe to fund new health technology ventures. Centralized health care systems control prices and reduce margins for innovators. The centralized systems provide innovation potential in the treatment of diseases requiring a lot of integration, but the results have been mixed.

Synthesis and Research Frame

Past studies on business ecosystems have mostly focused on software and the IT industries. This study provides new insights into the business ecosystem concept beyond the aforementioned industries. The research creates a frame that can be utilized to study the ecosystem phenomena in the health and life sciences in spatial contexts. This is done by discussing and analysing literature findings on business ecosystems, the dynamics and evolutionary mechanisms that affect them, the key conditions facilitating growth and innovation in business ecosystems in spatial contexts, and exploring the change drivers and barriers in health and life sciences business ecosystems. The key findings are presented in table 1.

As shown in table 1, various considerations are involved in studying health and life sciences business ecosystems in spatial contexts. The structure of a business ecosystem includes actors, platform(s)

TABLE 1 Key Findings and Research Synthesis

<i>Business ecosystems' structural elements</i>	
Actors	
• Private, public and non-governmental organizations (NGOs), which can also be categorized into: • Lead actors (keystones), niche players and intermediaries	
Platform(s)	
Regional coverage	
<i>Evolution and change dynamics</i>	
Evolution (long-term)	
• Social, economic, political, regulatory, competitive and technological changes • Life-cycle stage: birth, expansion, leadership, self-renewal or death	
Dynamics (short-term)	
• Innovation (complementing innovations, component innovations, competing and substituting innovations) • Co-evolution (collaboration and competition among various actors; self-organization, rules and constraints set by lead actors, competitive forces, regulators, laws, norms, and ethics) • Interaction with competing and converging ecosystems	
<i>Spatial innovation enablers</i>	<i>Health and life sciences' change factors</i>
Resources	Drivers
• Capital • Talent • Available networks • Adequate research activities	• Rising health care costs • Demographic changes • Advances in life sciences • Technology convergence
Culture	Barriers
• Social norms • Trust • Cooperativeness to support knowledge exchange and boundary spanning • Entrepreneurial culture	• Fragmentation and complexity of the systems and markets • Several influential stakeholders • Fragmented research efforts • Insufficient financing • Long R&D and approval cycles
Government support	• Intellectual property rights cost • Third-party payment system • Slow standardization • Risk-avoiding policies • Ineffective use of public procurement • Insufficient support for SMEs • Inadequate use of health professionals and lack of their business competencies
• Adequate infrastructure • Research funding • Enterprise-friendly policies and programs	

and regional coverage considerations. Evolution and change dynamics, in turn, involve the long-term and short-term mechanisms that affect the business ecosystem. Spatial innovation enablers are also relevant; these can be classified into factors related to resources, culture and government support. In addition, table 1 points out many influential factors driving change in health and life sciences ecosys-

tems. However, several change barriers also exist, which hinder innovations. Relevant research questions for future study purposes include:

- How do different actors facilitate and support innovation and growth in spatial business ecosystems?
- How do global business ecosystems adapt and use local settings to catalyst their innovation, competitiveness and growth?
- What are the most significant innovation barriers in health and life sciences business ecosystems and how should they be addressed?

Due to the complexity of business ecosystem phenomena, a research strategy that involves a case study approach is proposed. Multiple data collection methods including theme and semi-structured interviews must be utilized. The interviews should be conducted among informants who have in-depth information on the ecosystem under study. Relevant interview questions include the following:

- Who are the main actors and what are their roles in the ecosystem? How have the roles of the main actors changed through the years?
- What types of relationships exist between actors? How have these relationships changed through the years?
- What are the main characteristics of the ecosystem – spatially and globally?
- How is the spatial ecosystem connected to a global ecosystem and vice versa?
- What is/are the platform(s) of the ecosystem? How has/have the platform(s) changed through the years?
- Who provides the platform, defines the architecture and sets the rules?
- What is the role of health care providers, universities and research institutions in the ecosystem?
- How relevant is public funding, programs or policies for the ecosystem?
- What is the role of intermediary organizations?
- What factors drive the ecosystem growth?
- What factors are barriers for the ecosystem growth?
- What is the role of trust in the ecosystem?
- How will the ecosystem evolve in the future?
- What will change during the next years?

The research frame described above provides the basis for empirical studies of health and life sciences business ecosystems in selected spatial contexts. The frame aims to enable researchers to conduct systematic empirical research on business ecosystems and underlying phenomena. However, it should be noted that due to the complexity of the phenomena under study, the research frame developed in this paper cannot be considered final and will be refined iteratively during the research project. It must also be noted that this paper is based solely on literature findings. While the study focuses on business ecosystems in spatial contexts and the health and life sciences industry, the research frame can also be utilized in other contexts. Thus, further research is recommended to test the validity of the research frame via empirical studies in different types of contexts.

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