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Assessment of innovation ecosystems for technology roadmapping at firm level

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Thèse en vue en vue de l'obtention du diplôme de Philosophiæ Doctor

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Cette thèse intitulée :

Assessment of innovation ecosystems for technology roadmapping at firm level

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en vue de l'obtention du diplôme de *Philosophiæ Doctor*

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DEDICATION

To my family: Lucrecia Maciel my beloved wife, and my sons Amyr Bassis and Sami Bassis.

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Nihad F Bassis – Canada, The Montreal Summer 2019

RÉSUMÉ

L'environnement économique n'est plus le même et sa complexité évolue à une vitesse défiante aux entreprises basées sur la technologie. Même les entreprises non technologiques souffrent indirectement des conséquences du changement technologique et social. La relation entre les acteurs du marché est plus dynamique, elle est “en ligne”. En quelques secondes, les informations stratégiques peuvent être entre les mains d'un concurrent d'un simple *clic* sur un bouton de la souris.

De nos jours la façon dont nous envisageons la concurrence de points de vue industriels, sectoriels ou des clusters a ses limites ignorent de nombreux aspects commerciaux tels que la valeur capturée des relations informelles des acteurs sociaux, la coévolution entre entreprises concurrentes, les communautés sociales créant de la valeur pour les entreprises et autres qui montrent l'obsolescence de ces perspectives et des outils associés. Depuis le travail fondateur de James Moore intitulé “*The Death of Competition*” publié au début des années 90, on a beaucoup conjecturé sur la “nouvelle” innovation. Selon Moore, nous nous trouvons dans un scénario où la frontière de l'entreprise n'a aucune signification, mais son interaction intense avec d'autres acteurs indique sa capacité à innover dans un lieu appelé “écosystème de l’innovation”. Ce lieu est l'endroit où l'innovation a son importance grâce à un flux continu de connaissances qui capturent et créent de la valeur pour le client. Tout cela est articulé à travers des modèles commerciaux ouverts impliqués dans les interactions entre tous les acteurs participant à l'écosystème. Mais comment cartographier un écosystème, ses relations? Ses modèles d'affaires? Et surtout, comment identifier et évaluer ses stratégies bénéficiant uniquement aux entreprises et aux acteurs qui intègrent ce lieu ? Ces questions constituent cette recherche. Dans notre revue de littérature, nous identifions “l’état de l’art” des écosystèmes d'innovation (article 1). Pour comprendre les aspects empiriques de ce nouveau lieu d'innovation, nous avons développé une analyse de terrain à travers des tests, des conjectures précédentes, des comparaisons et une évaluation des résultats trouvés (article 2). En identifiant les concepts par l'observation sur le terrain et une revue littéraire systématique, nous avons développé un outil d'analyse pour l'évaluation de l'écosystème de l'innovation intégrée à la planification stratégique technologique (article 3). Les considérations de cette expérience sont partagées dans la section de discussion générale de la thèse et la dernière section concerne nos conclusions. Cette section identifie les principales contributions de la recherche entreprise par les

limitations de la recherche, mais aussi les opportunités à saisir pour la recherche future dans le domaine de l'innovation technologique.

ABSTRACT

The economic environment is no longer the same and its complexity changes at a challenging speed for technology-based companies. Even non-technological companies suffer in some indirect way the results of technological and social change. The relationship between market players is more dynamic, it is “online”. In a few seconds, strategic information can be in the hands of the opponent with just a click on the mouse button.

Nowadays, the way we view competition from industrial, sectoral or cluster perspectives has its limitations and ignores many business aspects like the captured value from informal relationships of social actors, the co-evolution between competing companies, the social communities creating value for companies and others that show the obsolete of these perspectives and related tools.

Since James Moore's seminal work entitled “The Death of Competition” published in the early 1990s, much has been conjectured about the “new” innovation. According to Moore, we are inside of a scenario where the frontier of the firm has no significance but its intense interaction with other actors indicates its ability to innovate in a *locus* named the “innovation ecosystem”. This *locus* is where innovation takes place through the continuous flow of knowledge that captures and creates value for the customer. All of this is articulated through open business models involved in interactions between all actors participating in the ecosystem. But how to map an ecosystem, its relationships? its business models? And above all how to identify and assess its strategies benefiting only the companies and actors that integrate this locus. These issues make up this research. In our literature review, we identify the “state of the art” of innovation ecosystems (article 1). To understand the empirical aspects of this new *locus* of innovation, we develop a grounded analysis and speculations by testing, comparing and evaluating the results found (article 2). By identifying constructs through field observation and a systematic evidence literary review we developed an analytical tool for assessment of innovation ecosystem integrated with technological strategic planning (article 3).

The considerations of this experience are shared in the general discussion chapter of the thesis, and the final chapter is concerning our conclusions. This chapter identifies the main contributions of the research undertaken by research limitations but also opportunities to be taken in future research in the field of technology innovation.

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LIST OF SYMBOLS AND ABBREVIATIONS

AIM(RaD)C - Abstract, Introduction, Materials and methods, Results, and Discussion Convention

AIMS – Association of Strategic Management

ASAC – Association of Canada Conference

BE – Business Ecosystem

CMO – Collaborative Market Orientation

DSR – Design Science Research

DUI – Doing-Using-Interaction

GMVN – Global Manufacturing Virtual Network

IE – Innovation Ecosystem

NSI – National Systems of Innovation

OECD – Organization for Economic Co-operation and Development

OI – Open Innovation

RSI – Regional Systems of Innovation

SI – Systems of Innovation

STI – Science-Technology-Innovation

StrT - Strategic Thinking

SysT - System Thinking

TRM – Technology Roadmap

UAV – Unmanned Aerial Vehicle

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CHAPTER 1 INTRODUCTION

Since innovation is becoming less focused on products and more on the new attributes, services and methods of distribution – capacities that cannot be copied overnight – new strategies have emerged in the competition arena (van der Zee et al., 1999). Some of these new strategies are known as cross-industry innovation, coopetition, "complementors", customer lock-in, standards-based profitability, among others (Cusumano, M. A. et al., 2002b; Gawer, A., 2009, 2014; Moore, 2013; Nikayin, 2014; van der Zee et al., 1999). The distinctive difference between traditional and new strategies are the boundaries in which they are developed and applied (Moore, 1996). Previously, strategies were designed only within the boundaries of a specific company. Nowadays the strategic design considers the company's relationships and interdependencies within its "Innovation Ecosystem" (IE) seeing that the value delivered to the customer comes from this network of companies (Mika et al., 2014).

A IE refers to the network comprising a focal firm, its suppliers, its complementors firms, and customers (Adner et al., 2010). IE concept was first proposed by (Moore, 1996, pp. 26-27) as "an economic community supported by a foundation of interacting organizations and individuals — the organisms of the business world" adding "the member organisms also include suppliers, lead producers, competitors, and other stakeholders". According Moore (1996) the key references of his concept were based on the works of: Nelson, R. et al. (1982), Anderson (1989), Rothschild (1990), Henderson (1989) and, more particularly, Astley et al. (1983). In the early nineties, Moore identified the existence of IE as a strategy for capturing and generating value by studying the strategies of companies such as AT&T, GeoPartners Research Inc., Intel Corporation, Hewlet-Packard, Royal Dutch and Shell Group.

In recent years, many researchers have been interested in the study of these emerging strategies that predominate within IE (Bogers et al., 2017; Cusumano, M.A. et al., 2019; Jacobides, Michael G. et al., 2018; Jacobides, Michael G et al., 2018). Also, there is now a considerable body of research about IE, among many, we can cite the following. Marco Iansiti, Professor at Harvard Business School, and his collaborators defined new concepts in the structure and dynamics of an

IE, including defining the different roles of actors in an IE and their strategies (Iansiti, 2004; Iansiti et al., 2002; Iansiti, Marco et al., 2004). Iansiti, in his book “The Keystone Advantage”, describes a way for organizations to understand how complex business networks behave, and to explore the possibilities for strategy formulation, innovation and operations management. In 2012, Adner developed the idea of Value Creation in Innovation Ecosystems in his work, “The Wide Lens: What Successful Innovators See That Other Miss” (Adner, 2012). Den Hartigh and his colleagues suggested new types of roles, governance framework and ecosystem health measurement (Anggraeni et al., 2007; Stolwijk et al., 2013). Velu et al. (2013) introduced the concept of collaborative market orientation, which is defined as a set of capabilities that are jointly built, maintained and exercised by members within an ecosystem. In 2015, in a research conducted by Rong, Ke et al. (2015c) a comparative analysis of theories considered two trends considered as potential challenges in the context of manufacturing industries: interoperability and uncertainty in the context of mobile computing industry. Among the various theories (Systems of innovation, Global manufacturing virtual network, Business network, Supply chain, International strategic alliance, Industry cluster and others) IE has been identified as the theory most apt to tackle the challenges of today’s emerging industries. Still, in the body of knowledge in IE, (Zhang Xiaoren, 2014) established the link between Open Innovation (OI) and IE.

According Zhang Xiaoren (2014), the IE theory solved the problem on how to achieve synergies through cooperation in an open network environment and broke through the limitations of traditional analytical methods providing a new theoretical framework for innovation. Through many researches, these synergies have pointed to OI as the background of strategies articulated in IE (Appleyard et al., 2017; Chesbrough et al., 2014; Curley et al., 2013; Pilinkiene et al., 2014; Wulf et al., 2016). Open Business Models like crowdsourcing (Shaughnessy, 2014), long-tail (Osterwalder et al., 2010), open source (Ying et al., 2011), revenue or cost sharing (Tuomo Kinnunen, 2013), peer-to-peer (Amit et al., 2015), orchestration (Ritala et al., 2013) and leverage customer data (Choudary, 2018) are some examples of open business models that are part of OI from an IE strategy perspective.

Practical issues have also emerged in the study of innovation ecosystems. Over the past few years, many case studies have been developed to identify empirical elements enriching the body of knowledge already developed and at the same time testing hypotheses for advancing research on

the subject. Among the case studies developed it was found that high-tech companies like Intel, ARM, Amazon, Facebook, Google, Microsoft, Oracle, SAP, Cisco, Qualcomm have been developing their strategies in the business world by applying the strategies nested in the Innovation Ecosystem (Adner, 2006, 2012; Cusumano, M.A. et al., 2019; Jacobides, Michael G et al., 2018; Moore, 2013; Rong, Ke et al., 2009; Van Alstyne et al., 2016). Through these case studies, it was possible to identify some fundamental differences between the traditional strategy models versus the models that adopt IE as a reference, an example is the supply chain. The traditional supply chain view, where value is based on the **production** of goods and services, while IE view its value is based on **knowledge exchange**[1] that drives proactive production of goods and services, thus the value stream gains priority in assessing competitive business environments. In this context, a challenge is imposed, *how to assess the competitive business environment toward on how strategies are practiced within IE?* The answer to this question can be reached from assessment tools. However, few tools exist for the analysis of firm strategies in ecosystems (Camarinha-Matos et al., 2010; Daidj, 2010, 2011; Weiller et al., 2013). According to Chesbrough et al. (2006, p. 245), "in systemic innovation, companies need new tools for foresight and shaping to manage the business environment."

The great challenge in terms of analytical tools are variables that were previously not part of the reality of the arena of business competitiveness. Among these new variables of the strategic game we have emergent strategies, coevolution (Camarinha-Matos et al., 2009; Daidj, 2010, 2011) and coopetition and collaboration. In the Innovation Ecosystem theory these variables are considered (Hellström et al., 2015; Tsvetkova et al., 2012).

1.1 Analytical tools in a strategic business

The need for analytical tools in a strategic business context is not new. The intensive use of drawing tools and strategic analysis like Mintzberg's 5 Ps for Strategy, Porter's fiver forces framework,

[1] In the context of this research, **knowledge exchange** and **value flow** or **value stream** are used as synonyms.

Strategic Assessment Model (SAM), Strategic Options Development and Analysis (SODA) are further proof that the ability to learn from the competition is emerging as an essential quality for innovative companies (van der Zee et al., 1999). Nowadays, strategy design tools are outdated and do not consider the complexity and the multilevel of innovation ecosystems, which are the own locus of innovation. In response to this need, we intend to fill this void by proposing and testing a toolkit[2] that provides an assessment of a company's surrounding IE to support its strategic design and execution, by emphasizing the adoption of a strategic thinking (StrT) mindset led by system thinking (SysT) principles were companies themselves need to be seen as systems that are embedded in a complex environment (Weissenberger-Eibl et al., 2019).

The assessment of an IE takes into consideration several elements of network strategies, such as emergent strategies, new and open business models, platform strategies, cross-industrial innovation, among others. These elements and multi-sided attributes – found in IE literature – are not contemplated in existing tools that support design strategies such as forecasting tools. The proposed toolkit – AStra (Assessment for Strategy) – was designed to fill this gap, as it integrates these elements and attributes in a value ecosystem perspective to facilitate and integrate the strategic design to the specific IE context. Thus, the purpose of the AStra toolkit is to explore, depict and communicate the interactions between the actors and their business models through emerging strategies with open innovation as the dominant model (Bathelt et al., 2017).

One of the original contributions of the thesis is at the intersection of technology strategy and open innovation, by embedding different roles and strategies, as well as collective strategies (co-evolution, co-creation, co-operation, collaboration, etc.), into a dynamic and competitive cross-industry landscape. This thesis also contributes to practitioners in the field of innovation management through the proposal of a strategic visual tool for strategy and ecosystem value analysis.

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[2] A toolkit can be defined as the integrated composition of various tools (Kerr et al., 2013) supported by artifacts, templates, quizzes, among other elements. The toolkit presented in this article is called AStra which means: "**A**ssessment of Innovation Ecosystems for new **Stra**tegies" or in a reduced form "AStra™" or "AStra Toolkit".

1.2 Thesis organisation

The structure of the thesis by articles is divided into eight parts as follows. **Chapter 1** presents the context and motivations of this research and why this work presents a contribution to research in the field of innovation strategies. The literature review is split in two chapters, because part of it resulted in the first article of the thesis. Therefore, **Chapter 2** is the first part of the literature review, in which the concept of strategy is presented in a historical perspective, followed by a presentation of related tools. As a second part of our literature review, the **Chapter 3** (article 1) develops deep literature presenting the "state of the art" of IE and contrasting it to the concept of Systems of Innovation (SI). The research thesis design and methodology are presented in **Chapter 4**. Next, **Chapter 5** (article 2) presents the principles and the logic behind the integration of IE and strategy through a tool, and the case studies that were used either to arrive to these principles or to test the resulting approach. **Chapter 6** (article 3) presents the resulting toolkit and details its test in two case studies. **Chapter 7** presents a synthesis of this thesis and discussions about this research and **Chapter 8** presents our conclusions.

CHAPTER 2 CRITICAL REVIEW OF THE LITERATURE ON STRATEGY

Innovation is a multidisciplinary subject. The possibilities of knowledge sources to be explored are numerous. For the achievement of the objective of this research, in the context of a literature review, two key themes were chosen: Strategy as the contextual scenario of this research and IE as new theory dedicated to the study of the innovation phenomenon.

In order to understand the meaning of the word "strategy" contextualized in this research, a literature review was developed from its historical concepts to the present moment reaching its operationalization through tools for strategic assessment and design support.

Given the importance of the subject IE as the theoretical basis of the research as a whole, a systematic literature review was made in the format of an article (article 1) that makes up the second part of this literature review to present the "state of the art" of the IE theory and its constructs. Thus, the literature review will be divided into two parts: chapter 2 is about strategy; in chapter 3, we present the meaning and practice of the IE and its theory and key elements.

2.1 Strategy in historical perspective

Strategy, from Greek στρατηγία *stratēgia,* means "art of troop leader; office of general, command, generalship" (Liddell et al., 2016). It is a high-level plan to achieve one or more goals under conditions of uncertainty. To understand its evolution and context in current periods a review is presented below.

In both literature and business, the definitions of the word strategy are diverse, and these definitions vary according to context and time. One of the first uses of the term strategy was made about 3,000 years ago by the Chinese war strategist Sun Tzu, who claimed "All men can see the tactics whereby I conquer, but what none can see is the strategy out of which victory is evolved" (Tzu, 2002).

Throughout the time, other works devoted to the study of strategy were written, including: "The Book of Five Rings" with moral principles of war authored by Miyamoto a Japanese samurai (Miyamoto et al., 1982), "The Art of War" (Italian: Dell'arte della guerra) a treatise by the Italian

Renaissance philosopher Niccolò Machiavelli (Mansfield, 2016) and many others. According to historians (Reid, 2014), the most brilliant and definition for "strategy" was developed by the French strategist André Beaufre as follows "*L'art de la dialectique des volontés employant la force pour résoudre leur conflit*" (Beaufre, 2012). These historical definitions had the word "strategy" imbued in a military context, where the challenge to beat the opponent was given by war. Afterward, the concept of strategy was extended to other fields of knowledge and social activities. Thus, the concept of strategy has become more complex according to its multidisciplinary and its numerous aspects analysis. In the last centuries, the set of theories and practices related to strategy have greatly increased thanks to several factors, including competitive economic environment, technological development and the need for optimization of the use of scarce resources. Today, "strategy" is part of the continuous reality of competition in the business environment.

2.2 Strategy in the context of business environment

Modern business strategy emerged as a field of study and practice in the 1960s (Ghemawat, 2000). A forerunner in the study of corporate strategy was Alfred DuPont Chandler Jr., professor of business history at Harvard Business School, who wrote extensively about the management structures of modern corporations.

Chandler wrote in 1962 that: "Strategy is the determination of the basic long-term goals of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals" (Chandler, A. D., 1962). His book "Strategy and Structure: Chapters in the History of the Industrial Enterprise" (1962) examined the organization of Du Pont de Nemours and Company, Standard Oil of New Jersey, General Motors, and Sears. In this work Chandler was one of the first to study the relationship between the structural configuration of a company and its strategy (Zott et al., 2008). The first seeds of the competitive strategy definition were planted. Later, Kenneth Richmond Andrews, a renowned professor at Harvard Business School, a father of corporate strategy and editor of the Harvard Business Review was credited with the foundational role in introducing and popularizing the concept of business strategy (Andrews, 1971).

Between 1960 and 1990 numerous other researchers have developed their studies on corporate strategy. One of the most relevant works was Mintzberg's titled "Strategy Safari: a guided tour through the wilds of strategic management". This book synthesizes the entire history and evolution

of strategic management in which they identify ten schools of strategy that have emerged over the past four decades.

In his work Mintzberg et al. (2005) found out prescriptive process and structured models reducing strategic planning to an analytical process of decomposing goals into actionable steps. It is well known that each model contributes a specific, limited view of the strategic situation. Strategic analysis requires many diverse views of the situation to be considered (Checkland, 1995). Mintzberg et al. (1998) argues strategy formation is not an arbitrary sequence of steps from which a fully formulated strategy emerges but an integrated system of continuous learning. This involves strategic thinking (Constantinos et al., 2000; Mintzberg, 2008) concerned with synthesis and creativity. The view of strategy as a creative, dynamic, responsive, and often intuitive, process within the framework of a largely unpredictable environment fits with the concept of strategic thinking (Graetz, 2002) and this is one of Mintzberg's greatest contributions on how we approach strategy from a dynamic and responsive perspective that reflects the reality of organizations. In this sense, many tools, approaches and techniques present characteristics that advocate: (1) collaborative strategy design through workshop sessions (Phaal et al., 2007; Phaal, R. et al., 2015), (2) the visual mapping of information (Jones, P., 2012; Phaal et al., 2016), (3) the analysis of diverse perspectives in the form of synthesized variables (Robert Phaal et al., 2000), (4) hypothesis-driven dialogues (Flanagan et al., 2009; Jones, P. H. et al., 2007; Liedtka, 1998; Massey et al., 1996), and (5) the encouragement of innovative ideas and insights not limited to borders of the company (Hahn, 2015; Heuer, 2011) are elements that value aspects that were not previously considered. Although Mintzberg ignored the school of System Thinking in his work (Haines et al., 2007), his research and publications have greatly contributed to a holistic view of strategy schools favoring the development of various strategy support tools.

2.3 Strategy support tools

Surrounded by the complexity of numerous variables of strategic design, numerous approaches, conceptual frameworks, tools and methods such as roadmapping, portfolio matrices and scenario planning are used to support the management of technology and innovation activities (Phaal, R. et al., 2015). Numerous research deals with the typology of tools (Kaufmann-Hayoz et al., 2001), visual aspects (Paroutis et al., 2015), conceptual aspects (Eppler, 2006), usability (Knott, 2008),

strategic tools (Jarzabkowski et al., 2015; Spee et al., 2009). Among them, a key strategic tool is roadmapping (Bassis et al., 2013; Bernal et al., 2009; Kamtsiou et al., 2013; Nimmo, 2003), which has become one of the most widespread approaches for supporting innovation and strategy (Phaal et al., 2007).

A technology roadmap (TRM) is a strategic tool widely used by manufacturing firms, to foster collaboration between firms in an industry (More et al., 2015). The TRM approach is very flexible, and the terms ‘product’ or ‘business’ roadmapping may be more appropriate for many of its potential uses (Phaal, R. et al., 2001). Since the initial development of the TRM approach in the late 1970s by Motorola the method has been adopted by many different organizations in different domains, sector and national levels, to support a range of different strategic goals.

Although roadmaps are used for a range of purposed and can take various forms (Phaal, Farruk, and Probert, 2004a), they generally aim to capture a high level, synthesized and integrated view of strategic plans or business case.

In addition, they seek to answer three simple questions considering a range of perspectives, which include markets, products, and technology: (1) Where are we going? (2) Where are we now? (3) How can we get there? These questions are represented Figure 2.1 in a canvas as follows.

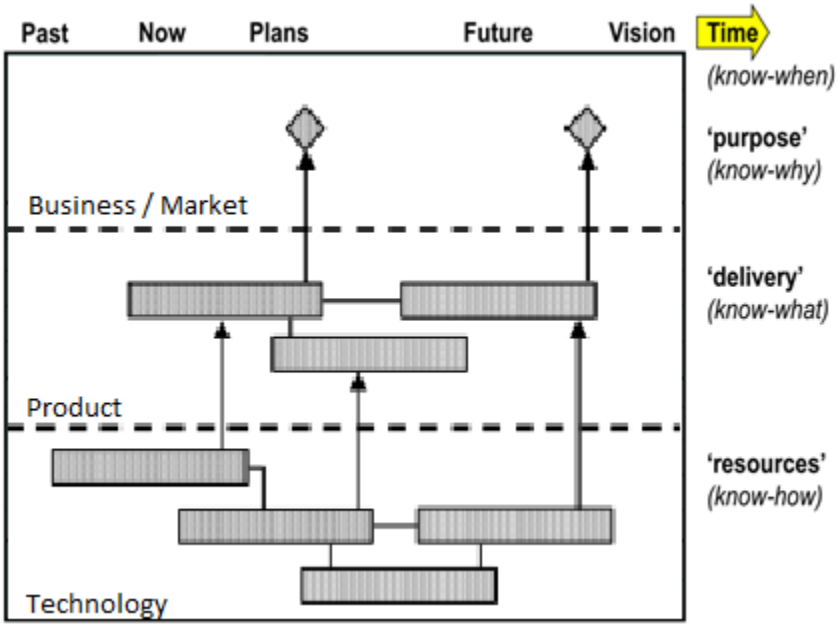


Figure 2.1 : The TRM approach

Source: adapted from Phaal (2003)

Early adopters of the TRM approach include firms in the customers electronics sector, such as Philips (Groenveld, 1997) and Lucent Technologies (Albright & Kappel, 2003), and also organizations in other technology-intensive sectors – primarily aerospace and defense. A great success in using the TRM happened in Canada.

Industry Canada, the Canadian government department responsible for industrial development, launched the technology roadmapping initiative in 1995 as part of its strategic plan to support and promote Canadian innovation. Industry Canada's technology roadmapping initiative had a single purpose: to strengthen Canadian competitiveness by helping industries to identify and develop innovative technologies necessary for success (Martin G. Moehrle, 2013). Since 1995, Industry Canada co-sponsored 39 technology roadmaps, with one under development, involving more than 2700 companies and more than 200 non-industry partners (universities, research institutions and associations) (Nimmo, 2013).

A key landmark in the evolution of the approach was the development of the sector-level semiconductor roadmap, initially in the U.S. and then internationally (Phaal et al., 2007). The development of an effective roadmapping process within a business is reliant on significant vision and commitment to what is an interactive, and initially exploratory, process (Phaal et al., 2007).

In terms of usability, the TRM tool stands out for its great conceptual apparatus and tooling. Numerous templates are available (Phaal et al., 2016) on a site dedicated to the promotion of the tool and hundreds of research related to its use. A social networking discussion group promotes the exchange of experiences in the field of practice. Guides and templates have been published to support tool users (Phaal, Robert et al., 2001).

Supported by an established scientific community, TRM has in recent years, found its evolution either by adopting agile methodologies or developing new templates and supporting artifacts (Keer et al., 2015).

His recent approach based on value analysis (Phaal, R. et al., 2015) is a clue as to which dimensions can be assessed in the context of technological innovation and thus will serve in the context of this research as a reference in developing a proper approach from the perspective of innovation ecosystems.

CHAPTER 3 CRITICAL REVIEW OF THE LITERATURE (SECOND PART – ARTICLE 1: "SYSTEMS OF INNOVATION AND INNOVATION ECOSYSTEMS: A LITERATURE REVIEW IN SEARCH OF COMPLEMENTARITIES"

> "The greatest danger in times of turbulence: it is to act with yesterday's logic" – (Peter F. Drucker)

3.1 Presentation of the article

Part of this research literature review resulted in the first article of this thesis. The recent surge of interest in innovation ecosystems in strategy research and practice has mainly focused on what ecosystems are and how they operate. There are few systematic studies to validate and understand the constructs of this new theory. This article is the first publication in this sense and presents the "state of the art" of innovation ecosystems in a comparative way and related to another theory already established i.e. the Systems of Innovation (SI) theory. Then, through the analysis of the most relevant and extensive biography on the subject, this systematic review takes stock of the theory (scientific approach, definition, typology, terminology, constructs, scope, logic unit), but also the practice (best practices, industry role, boundaries, approaches to analyzing). This systematic review establishes the coherence and theoretical foundations necessary to achieve the research objectives. Finally, a proposal of cross-fertilization between some common elements found benefiting both research communities.

The article entitled "*Systems of innovation and innovation ecosystems: a literature review in search of complementarities*", co-authored by Fabiano Armellini, has already been published in the Journal of Evolutionary Economics (Vol. 28 Issue 5, pages 1053-1080) on 12 December 2018.

Abstract

This paper aims to clarify to what extent the emerging theory of innovation ecosystems (IE) and the theory of systems of innovation (SI) are complementary and then identify how its communities could benefit from cross-fertilization. We performed a critical literature review of both topics using meta-synthesis as a method to identify, analyse and compare the two theories. Using a framework, this paper explores the elements belonging to each theory's domain, in order to identify the key factors necessary to compare the two theories. The results of this analysis show that both theories involve the assessment of three key aspects: the understanding of innovation activities, the role of the agents involved, and the interaction and resulting networks among them. A similarity was found showing that these two different theories are applications of System Thinking approach. Another finding, which has not been mentioned in previous research on the topic, is that the construction of the initial concepts of the IE theory was originally rooted in several SI elements. Finally, we found key factors that may be the cross-fertilization link between the two communities that represent each theory.

Keywords

Innovation ecosystems, Systems of innovation, Technology innovation

3.2 Introduction

Developing technologies emerge within a complex context of interactions among different stakeholders, including industrial players, investors, entrepreneurs, scholars and governments. In some cases, these technological innovations are based on platforms where the interactions take place through massive data exchange between machines, such as the IoT (internet of things) and machine-to-machine systems (Moore, 2013). Leveraging the business opportunities from these new technologies often requires new business models that have a strong interdependence with the value chain and that have increasingly shorter life cycles (McKinsey, 2013, 2015; OECD, 2013; Wyss Institute, 2011). This economic scenario is characterized by the combination of three interconnected factors: (i) the increasing ease at transcending borders (internationalization), (ii) the removal of artificial trade barriers (liberalization) and (iii) the increasing ability to exchange data using information technologies (Hayes et al., 2004; Strikwerda, 2010; van der Zee et al., 1999). The global market also adds several other complexities for emerging technologies, related to security, regulation, logistics and legal compliance (OECD, 2013, 2015; Warwick, 2013).

A vast array of theories provide explanations for the specific phenomena found within the field of innovation. In the midst of this complex and ever-changing scenario, scientific communities and industrial sectors must ask themselves, after all, how to benefit from resources (methods, techniques, instruments, etc.) and discoveries provided by other research communities that operate in the same field of research. Fully established theories as SI[3] have reached stages of maturity characterized by a certain self-criticism in which even fundamental concepts are questioned. A good example of this is the article “National innovation systems - analytical concept and development tool” on the maturity of SI theory from Lundvall (2007a). On the other hand, emerging theories such as IE are still constituting their concepts, developing new models of understanding, proposing tools and creating their agendas and research groups (Rong, Ke et al., 2015c). Part of this self-affirmation process consists of differentiating itself from contiguous theories. In this vein, our motivation with this article is to clarify to what extent the theories of

[3] In the literature, the terms "National/Regional Innovation Systems," "Systems of Innovation" and "National/Regional Systems of Innovation" are used interchangeably. In this paper, the term "Systems of Innovation" (SI) is used to refer to all these terms.

innovation ecosystems (IE) and systems of innovation (SI) differ and are complementary to one another, and then identify how communities could benefit from cross-fertilization.

To that effect, the article was structured according to the AIM(RaD)C convention (Cargill, 2009), as Figure 3.1 illustrates. Thereby, the article begins with its abstract, develops an introduction (session 1), presents the methodology (session 2), which is applied with the support of a comparative framework of theories to perform a review of the SI theory (session 3), of the IE theory (session 4) and a comparative analysis of theories in search of complementarities (session 5) structured between literary review, followed by a summary in table format with the results found in the literature. The article ends with some conclusions (session 6).

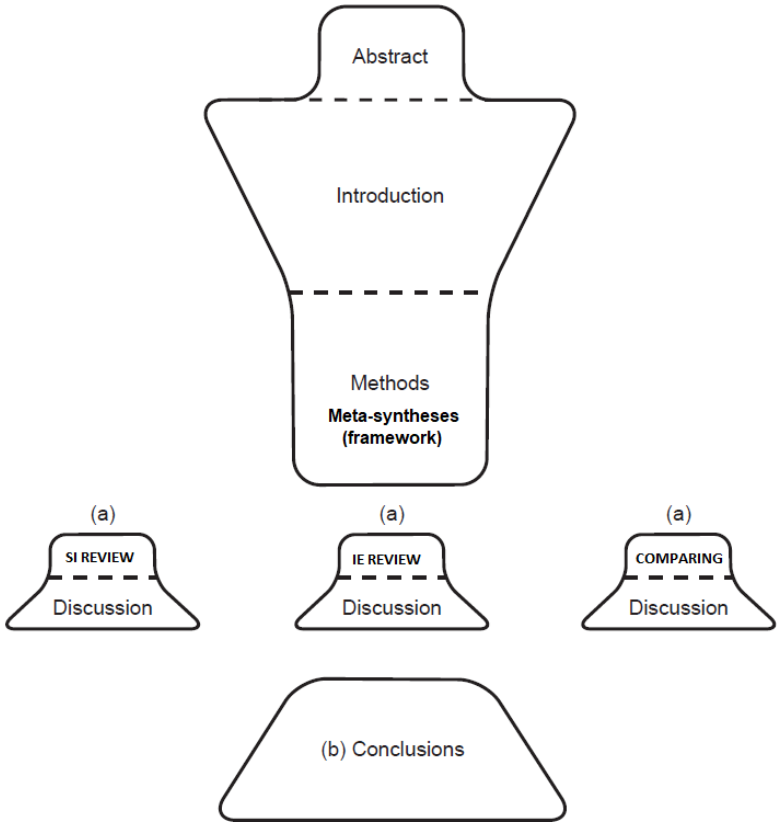


Figure 3.1 : The article structure

(a) The Results and Discussion are presented together in a single combined section.

(b) This means that a separate section is needed at the end to bring the different pieces (SI Review, IE Review and Comparing) of discussion together.

3.3 Research Methodology - Meta-Synthesis

Given our motivations, this paper is clearly a literature review. This review aims to identify the main elements of scientific production that characterize the bases of the two theories under study and, from there, to seek points of interaction and complementarity between them and consequently find elements of cross-fertilization. According to a number of authors (Ackerson, 2007; Cronin et al., 2008; Grant et al., 2009), there are fourteen different types of literature review, which must be chosen from according to the overall aims and objectives of the review.

The method chosen for this paper is meta-synthesis research method. Meta-synthesis is a non-statistical technique used to integrate, evaluate and interpret the findings of multiple qualitative research studies (Cronin et al., 2008). Meta-synthesis involves analyzing and synthesizing key elements of each concept, based on the identification and analysis of fundamental and seminal works, in order to transform individual findings into conceptualizations and interpretations (Polit et al., 2014).

Given that both theories in focus here are related to grounded theories (Lundvall, 2007b; Parisot et al., 2017a), where such works exist, meta-synthesis is the most appropriate method for a systematic comparison of the IE and SI (Zimmer, 2006).

The literature review was restricted to the main authors of both theories under study, and also in articles derived directly from the founding authors of the theories presented in this paper. Articles that do not base their research on the foundations of SI or IE theories were not considered, in spite of the use of similar analogies, approaches and metaphors with the same terms or meanings used in SI and IE theories. In order to identify which variables would be the most important for the comparative literary analysis of the two theories, an ontological framework was used to give structured support to the key elements that constitute the logical and fundamental architecture of each theory. The variables chosen from the comparative purpose of the literature review based on meta-synthesis are presented in Table 3-1 that identifies the fundamental themes for a comparison of theories and the key factors for a detailed analysis.

The integrated results of the two analyses are presented in one ontological framework in order to highlight the key factors necessary to compare the two theories (Figure 3.2). In the SI review, the seminal works reviewed were of those of Lundvall, Freeman and Nelson, the three “founding

fathers" of the concept, combined with other conceptual publications (review papers or theoretical essays). In the case of IE, the seminal works are the three main publications of Moore on Business Ecosystems, combined with other conceptual publications that build upon Moore's definitions.

It is worth clarifying that, in our review of the literature many articles (especially the most cited in the subject) treat business ecosystem (BE) and innovation ecosystem (IE) as interchangeable terms (Adner, 2006; Adner et al., 2010; Gawer et al., 2014; Gawer, A., 2014; Gomes et al., 2016; Kapoor et al., 2013; Nambisan et al., 2013; Overholm, 2015; Zahra et al., 2012).In this sense, and considering that this is already an established fact in the research community in BE we will use the same semantic between the terms always considering the restricted use of authors who derived or evolved their research based on the essential elements of the theory of BE.

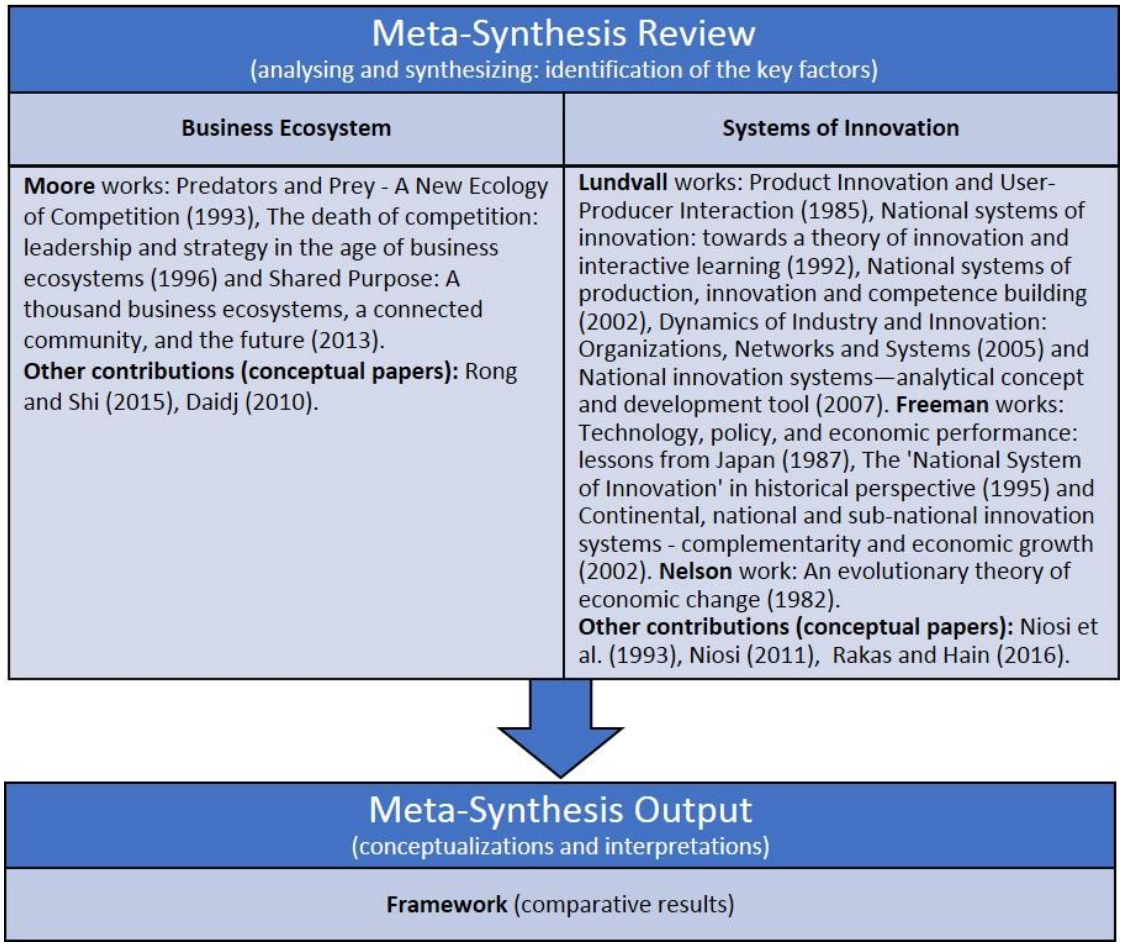


Figure 3.2 : Meta-synthesis methodology

Through the meta-synthesis literature review methodology, the three "fundamental theoretical themes" that were identified as relevant for comparing IE and SI theories are **concepts**, **literature** and **framework structure**. These key areas and their factors are presented in Table 3.1. Note that these areas of comparison are explored in detail later in this work.

Table 3.1 : Key factors necessary for the comparison of the SI and IE theories

Fundamental theoretical themes	***Key factors***
Concepts	Key concepts, Synonyms, Related terms, Target of the concept, Scope application area and Logic unit
Literature	Seminal works, Key authors, Key topics, Authors who evolved the concept, Universities involved, Case, Heritage and Some inspirations
Framework structure	Scientific approach, Core discipline, Theoretical basis, Boundaries, Network boundaries, Industry role, Approaches to analyzing

3.4 Systems of Innovation Review

3.4.1 Antecedents

The concept of SI emerged in the late 1980s, coined by Freeman to describe the congruence in Japanese society (Soete et al., 2009) between various kinds of institutional networks in "private and public sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1987). In line with earlier work on long waves of economic and technological development (Soete et al., 2009), Freeman's focus is on the broad interaction between technology, social embedment and economic growth and feedback loops reinforcing the system (Soete et al., 2009). Freeman's contribution was followed a year later by a book edited by

Dosi (1988), which included three chapters on the SI concept as proposed by Freeman, Lundvall and Nelson.

3.4.2 Systems of Innovation as a System Approach

The systems approach to the analysis of economic and technological change is not new (Carlsson et al., 2002). Several systems approaches have been developed in order to analyze technological innovation as a system. A system is a set of interacting elements with interrelationships among them (Bertalanffy, 1969) along with a combination of those interacting elements organized to achieve one more stated purpose (INCOSE, 2006). According to Carlsson et al. (2002), systems are made of components, relationships and attributes. Social systems are interrelated sets of practices, institutions and roles (Niosi, 2011; Niosi et al., 1993). From an economic perspective, one of the first concepts of systems SI emerged from the work of List (1841). His concept of national systems of production and learning took into account a wide set of national institutions, including those engaged in education, training and infrastructure, such as transportation networks for both people and commodities (Freeman, 2002; Lundvall et al., 2002), and was a counterpoint to the liberal economic model that was the dominant theory at the time.

One hundred years after Friedrich List's book, Leontief (1941) published “The structure of American economy - an empirical application of equilibrium analysis”. In this work, the approach of “analysis of production systems with innovation” was developed as an analytical tool focusing on sectors of the economy (Lundvall et al., 2002). Over the following years, other approaches were developed as tools for analysis of innovation systems. Among them, the most widely known is the “Innovation System.”

3.4.3 Systems of Innovation as a Theory

Initially, the SI concept was introduced as “Innovation Systems” by the evolutionary economist Bergt-Åke Lundvall (Freeman, 1995). Based on the joint work of Lundvall, Freeman and Nelson, it became “Systems of Innovation” (Dosi, 1988).

In more general contexts, this theory remains known as “Systems of Innovation”; however, when applied to specific geographical regions, it is also known as “regional systems of innovation (RSI)” or “national systems of innovation (NSI)” when it analyzes the economy of a whole country. Other

systems operating at the national level are referred to as “social systems of innovation” and “national business systems.”

Two definitions of the term SI from the theory founders, among the various found in the literature, have become the most widespread, according to the Organisation for Economic Co-operation and Development, OECD (1997). The first one defines SI as *“the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge (...) and are either located within or rooted inside the borders of a nation state*” (Lundvall, 1992). The second states that SI is *“the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies*” (Freeman, 1987). Besides these two definitions, there are two others that are often used to introduce the concept. Metcalfe (1995) defined an SI as “that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts which define new technologies”. Finally, Patel (1994) defined it as “the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country”.

The main co-authors of the evolution of the term SI were Freeman, Nelson and Lundvall, through chapters of the book “Technical change and economic theory” (Dosi, 1988). Based on empirical studies giving strong emphasis to people, organizations and competence, the term SI reflects a grounded theory as a scientific approach, though the “scientification” of the term was not the purpose of the “founding fathers” of the theory.

The theory “Systems of Innovation” is a combination of four elements: 1) the neo-Schumpeterian reinterpretation of national production systems, 2) empirical work based on the home-market theory of international trade, 3) the microeconomic approach to innovation as an interactive process and 4) insights in the role of institutions in shaping innovative activities.

The two main areas of application and contribution for SI derive from these elements. The first two elements concerns regional development and public policy for science, technology and innovation

(Edquist, 2001); (Boschma, 2004). The other two elements build upon the assessment of knowledge flows, which is a central issue in the SI study (OECD, 1997). Therefore, SI studies have a significant contribution to the knowledge management literature, especially for the identification and assessment of the importance of new types of knowledge and their respective flows within an SI. Some of the types of knowledge include tacit versus explicit knowledge (Cooke et al. (1997), STI (science-technology-innovation) versus DUI (doing-using-interaction) (Jensen et al., 2007) and knowledge produced in a disciple-specialized mode (mode 1) versus one produced in a transdisciplinary-networked mode (mode 2) (De la Mothe et al., 2001).

3.4.4 Specialization of the SI theory

In "National innovation systems – analytical concept and development tool," Lundvall (1992, 2007b) clarified that, since it takes on different meanings in different contexts, the NIS concept is not simply a theoretical concept. Rather, the NIS offers a broad and flexible framework for organizing and interpreting case studies and comparative analyses. It is natural then that the SI theory would be strengthened by new theoretical elements and specialization fields.

One notable example is the innovation taxonomy, drawn from the works of Pavitt (1984) and Leontief (1941), which uses an analogy taken from Darwin's evolutionary theory applied to an economy, a common practice among evolutionary economists (also a constant, by the way, within the IE theory). Beyond policy making, Pavitt's taxonomy contributed to a variety of fields within innovation studies (Archibugi, 2001), including organizational behavior and business process mapping at the firm level. The main contribution of the taxonomy is the view that no one-fits-all model would do in organizing and understanding the processes of innovation and technological change. Another important addition to the SI theory is the triple helix model (Etzkowitz et al., 1995), which found its inspiration in the Sabato and Botana triangle (Sábato et al., 1968). This model contributed largely to the understanding of the complementarities of the main agents of an SI from both the public policy and knowledge management perspectives (Ranga et al., 2013).

Through other researchers, contributions were developed with focus on different perspectives:

- Technological systems (Carlsson et al., 1994)
- Regional systems of innovation (Cooke et al., 1997)

- Sectoral systems of innovation (Breschi et al., 1997)
- Industrial clusters (Porter, 1990).

Some of the most comprehensive research on the different approaches of SI was developed in "The Development of Innovation System Research: Towards an Interdisciplinary and Multidimensional Approach?" (Rakas et al., 2016). In this article, the researchers showed the intensive interdisciplinarity of these approaches and highlighted the increase in the studies of SI with a focus on management and organization of innovation, which primarily focuses on a firm-level analysis. According to Rakas et al. (2016), new approaches were developed based on the seminal works of Nelson, R. R. (1993), Freeman (1987) and Lundvall (1992). These approaches differ by analytical and conceptual focus, elements and dimensions emphasized, and system boundaries and units of analysis. The most frequently used units of analysis are regional, sectoral, technological, business and social systems of innovation and production. Finally, it is important to recall that the "(…) focus on innovation systems is less reflecting a theoretical abstraction and more the practical needs of the participants in the complex division of productive and innovative labour in modern economies." (Lundvall et al., 2002). However, as one may infer from its applications and later definitions, the focus has been given to the "practical needs" of local policy makers (government) to attract and retain innovative players to a specific region or country, and for boosting innovative performance therein.

3.5 Innovation Ecosystems Review

3.5.1 Antecedents

Today's industry is divided into a large number of segments, each producing specialized products, services and technologies. The degree of interaction between firms in a given industry is astounding, with hundreds of organizations frequently involved in the design, production, distribution or implementation of even a single product (Iansiti & Levien, 2004). In this context, a business cannot be considered relevant only from a sectoral viewpoint (Moore, 1993, 1996), but rather must be viewed as an entity belonging to something bigger, more complex and borderless, which we call the Business Ecosystem (Daidj, 2010, 2011; Rothschild, 1990).

The use of the analogy between business and an ecosystem was first used in the book of Rothschild (1990) “Bionomics: The Inevitability of Capitalism." Numerous other publications adopted the same analogy, though from different perspectives. Among the several analogies that emerged, the best known is the industrial ecosystem, digital business ecosystem and entrepreneurship ecosystem (Pilinkienė & Mačiulis, 2014). These analogies have been used in many publications in the form of metaphors and similarities. Yet, despite how often these terms are used in research, there is no apparent agreement on how they are defined and how they should be applied (Bechtel, 2009). In addition, the terms often appear interchangeable and are often used inappropriately. In order to understand the concept of BE, it is essential to understand its origins, semantics and constructs, as well as the current research on the topic.

3.5.2 Innovation Ecosystem as a Theory

IE as a concept was first proposed by Moore (1993), and was referred to as “Business Ecosystem” (BE). The concept was developed with a logic unit of analysis focused on "business opportunities" through the interactions of competition and co-operation. Moore (1993, 1996) reference to the evolutionary concept of BE was based on the following works: Nelson, R. et al. (1982), Anderson (1989), Rothschild (1990), Henderson (1989) and, more particularly, Astley et al. (1983) and Astley (1985). The philosophical inspiration of Moore's work was based on the Gregory Bateson book, “Mind and Nature” (Bateson, 1979). In terms of biology and evolution as technical constructs of the "business ecosystem" concept, Moore built his metaphor (Moore, 1993, 1996, 1998) using the work: “The Diversity of Life” authored by Wilson (1992).

In his first publication on the subject, Moore defined “business ecosystem” as “an economic community supported by a foundation of interacting organizations and individuals — the organisms of the business world” (Moore, 1993, 1996). As an introductory concept, it is clear that several entities are related in the context of “the business world.” Moore’s research was based on the competitive technology environment, focusing on leadership and strategy. He thus presented concepts focused on business opportunities. Some of the companies that were part of Moore's research were AT&T, GeoPartners Research Inc, Intel Corporation, Hewlet-Packard, Royal Dutch Shell Group and Sun Microsystems. In the context of “the economic community,” Moore (1996) says, “The economic community produces goods and services of value to customers, who are

themselves members of the ecosystem." This shows his intention of proposing the BE as a network oriented towards the value delivered to customers. "The member organisms also include suppliers, lead producers, competitors, and other stakeholders" (Moore, 1996). The inclusion of competitors as part of the same ecosystem is an innovative concept among the various models for business network analysis.

"Over time, they (ecosystem participants) co-evolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies" (Moore, 1996). To thrive over time, the system (ecosystem management) must adapt to changes in the business environment through the intentional acts and coordination efforts of managers and entrepreneurs (Teece, 2015). According to Moore (1996), "those companies holding leadership roles may change over time, but the function of the ecosystem leader is valued by the community because it enables members to move towards shared visions to align their investments, and to find mutually supportive roles." These ecosystems have no fixed boundaries, and they are in dynamic movements of co-evolution together with other members of the business ecosystem (Gueguen et al., 2004). In the same way, Torre et al. (2015) define IE as an economic environment with reciprocal exchanges, with different types of relationships acting as a system of interactions. However, one striking feature of IE theory is that it assumes that the sharing of skills and roles may happen, in some cases, even without leadership hegemony.

It is important to mention that in IE, long-term wealth is determined by relationships rather than by transactions (Kandiah et al., 1998). In terms of shared capabilities, Remneland et al. (2013) add that IE can enable a value creation strategy conducted outside the boundaries of the company through the structuring of an open innovation model. Likewise, Gawer et al. (2014) claim that in a IE, "the value co-creation process is set to create more value for the ecosystem's end users, together, than the individual players could generate as independent actors."One of the deepest and richest research works developed recently was the publication, "Understanding Business Ecosystems." This work evolved as a result of three annual round tables on ecosystems: the International Association of Strategic Management (AIMS) in 2010 and 2012, and the Administrative Sciences Association of Canada Conference (ASAC) in 2011 (Letaifa et al., 2013). The goal of this work was to develop an integrative synthesis of the various issues identified during these academic events.

Many other contributions were made over the last few years. The latest research comes from Shi and Rong. Their case studies allowed the publication of the first step in the construction of a Theory of Business Ecosystems. This work systematically examines innovation ecosystems in an emerging industry context while fundamentally exploring and identifying four essential areas of innovation ecosystems: the innovation ecosystems' key constructive elements, their typical patterns of element configurations, the five-phase process of their life cycle and the nurturing strategies and processes from a company perspective (Rong, Ke et al., 2015c). Their previous contributions include the proposal of “the 6C framework,” used to analyze the data collected from case companies and to identify three patterns of IoT-based innovation ecosystems (Rong, Ke et al., 2015b; Rong, Ke et al., 2009; Rong, Ke et al., 2013b; Shi et al., 2003).

Finally, the most solid and current researches that have contributed to the evolution of the theory of ecosystems of innovation are from two recent articles: "*La théorie substantive des écosystèmes d'affaires selon James Moore*" authored by Parisot et al. (2017b) and "*Une lecture Lakatosienne de l’approche par les Ecosystemes d’affaires*" also from the same authors (Parisot et al., 2017a). Based on previous research by Edouard et al. (2011), its authors develop a careful analysis of the process of Moore's theorization in ontological, epistemological and methodological terms. Parisot et al. (2017b) present a meticulous mapping of the main specializations (hypotheses) of concepts and theory of IE published in articles from the years 1993 to 2014, pointing out that the approach of Innovation Ecosystems constitutes an important theoretical and conceptual advance in the field of strategic management.

3.5.3 Comparison of Different Ecosystem Analogies

The BE concept proposed by Moore evolved during the Internet bubble (or dot-com bubble). This event was one of the key references in Moore's studies, as its negative effects were still being felt in the Silicon Valley between 1990 and 1993 and had prompted new business strategies. In that same period, new cross-industry relationships and new alternatives for production emerged. As well, a wave of startups, the emergence of new business models and new technologies, such as the Internet of things, Cloud services and 3D printers, emerged. All of these factors created new and more complex networks of business, with interactions that resulted in yet new products and services.

Between 2002 and 2004, Marco Iansiti, Professor at Harvard Business School, and his collaborators defined new concepts in the structure and dynamics of an IE, including defining the different roles of actors in an IE and their strategies (Iansiti, 2004; Iansiti et al., 2002; Iansiti, Marco et al., 2004; Valkokari et al., 2017). Iansiti, in his book entitled “The Keystone Advantage”, describes a way for organizations to understand how complex business networks behave, and to explore the possibilities for strategy formulation, innovation and operations management.

Between 2001 and 2004, Nachira et al. (2006) developed the concept of Digital Business Ecosystem (DBE), which was targeted to technology SMEs (small and medium-sized enterprises). A year later Moore began to use the term DBE of this research. The research related to DBE was triggered by Go Digital and was aimed at boosting ICT adoption by European SMEs. Nachira’s research refers to a new interpretation of “socio-economic development catalyzed by ICTs,” emphasizing the co-evolution between the IE and its partial digital representation - the digital ecosystem. A year later, Moore began to use this term in his research.

Between 2004 and 2006, two main contributions came from Peltoniemi, M. et al. (2004) and Peltoniemi, M. et al. (2005): the five key features of a innovation ecosystem (Complexity, Self-organization, Emergence, Co-evolution and Adaptation) and a proposed governance framework by adopting system complexity and evolutionary theory. In the period between 2004 and 2013, Den Hartigh and his colleagues suggested new types of roles, governance framework and ecosystem health measurement (Anggraeni et al., 2007; Stolwijk et al., 2013).

Between 2006 and 2013, Adner and his colleagues regarded the innovation ecosystem as the structure of technology interdependence (Adner, 2006; Adner et al., 2010; Leavy, 2012). In 2012, Adner developed the idea of Value Creation in Innovation Ecosystems in his work, “The Wide Lens: What Successful Innovators See That Other Miss” (Adner, 2012). Adner (2012) in his book clearly states that his work is a continuation of Moore's work. One of the purposes of his work was to answer such questions as, "how the structure of technological interdependence affects firm performance?" and "how to develop an innovation strategy in an innovation ecosystem?"

In 2015, in research conducted by Rong, Ke et al. (2015c) a comparative analysis of theories took into account two trends considered as potential challenges in the context of manufacturing industries: interoperability and uncertainty. The case study was based on a mobile computing

industry. Among the various theories (GMVN, Business Network, Suply chain, International Strategic Alliance, Industry Cluster and others), IE has been identified as the theory most apt to tackle the challenges of today's emerging industries. Finally, the IE analogies are summarized in a comparative table (Table 3.2) from the paper "Comparison of Different Ecosystem Analogies," by Pilinkienė et al. (2014) which was the first article to compare the use of ecosystem terminology taking into account James Moore's theory of innovation ecosystems. This table presents a comparison of the different conceptual variations that emerged from publications on ecosystems approaches. Not all of them have links to Moore's theory of IE.

Table 3.2 : Comparison of different ecosystem approaches

Adapted from Pilinkienė et al. (2014)

Ecosystem analogies	***Industrial ecosystem***	***Innovation ecosystem***	***Digital business ecosystem***	***Entrepreneurship ecosystem***
Environment	Local; industrial environment	From local to global; inter-organizational, political, economic and technological environment	From local to global; digital environment	Local; specific location
Actors	Manufactures and consumers	Entrepreneur; large and small enterprises; educational institutions; research institutions and laboratories; venture capital firms; financial markets; government institutions	Research and education organizations; innovation centres; small and large enterprises with their associations; local government and public administration	Financial capital; educational institutions; culture; support measures; human capital; markets; government institutions; nongovernment institutions; entrepreneur; large and small enterprises
Key determinants affecting ecosystem performance	Industry and environment interaction; interaction between ecosystem actors	Resources, governance, strategy and leadership, organizational culture, technology. interaction between ecosystem actors	Services and technological solutions, business and knowledge; interaction between ecosystem actors	Opportunities, skilled people and resources; interaction between ecosystem actors

3.6 Comparative Analysis between the theories

3.6.1 Comparative Analysis: Concepts

Moore (1993, 1996) coined the term business ecosystem as “an economic community supported by a foundation of interacting organizations and individuals. ” It is a dynamic structure, centered on a given firm, composed of a population of interconnected organizations in a common technology platform (Peltoniemi and Vuori, 2004), which goes beyond the core business agents (direct suppliers, core contributors and distribution channels) to embrace its whole supply chain, as well as other indirect agents and stakeholders. Business ecosystem is the evolution and an extension of the traditional concepts of a business value chain, cluster and value networks (Daidji, 2011; Torre and Zimmermann, 2015). Likewise, the SI approach “stresses that the flows of technology and information among people, enterprises and institutions are key to the innovative process (…) [which is] the result of a complex set of relationships among actors in the system, which includes enterprises, universities and government research institutes.” (OECD, 1997). However, the center of the analysis is not an individual firm, but the location (a region or a country) to which it belongs (Patel and Pavitt, 1994). In this way, we can clearly see that both the IE and SI theories are distinct from one another, not only in semantics, but also in structure. Though both terms are directly linked to the study of innovation, they differ in terms of prospects, actors, results, relationships and distinct criteria. Regarding audiences and logic units of analyses, even though IE and SI are complementary in the study of innovation, each theory focuses on a distinct public.

While SI helps “policy makers develop approaches for enhancing innovative performance in the knowledge-based economies” (OECD, 1997), IE was developed to “help executives anticipate the managerial challenges of nurturing the complex business communities that bring innovations to market” (Moore, 1996). While both theories analyze interactions in networks, IE is focused on the development of business analysis in order to develop business strategies. On the other hand, SI is dedicated to understanding the flow of information and knowledge related to the technological development of a nation or specific region. This comparative analysis is summarized in Table 3.3.

Table 3.3 : Comparative Meta-Synthesis Framework – Concepts

Concepts	***Comparative framework***	
	SI	**IE**
Key concepts	"...The elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state" Lundvall (1992)	"An economic community supported by a foundation of interacting organizations and individuals — the organisms of the business world" Moore (1993)
Synonyms	National Systems of Innovation (NSI) Innovation Systems (IS) Systems of Innovation (SI) National Innovation Socio-Economic Formations Regional Systems of Innovation (RSI)	Business Ecosystem (BE) Innovation Ecosystem (IE)
Related terms	Social systems of innovation National business systems Technological systems Regional systems of innovation Sectoral systems of innovation	Innovation ecosystem Digital ecosystem Software ecosystem Platform ecosystem Entrepreneurship ecosystem Industrial ecosystem Economic ecosystem Bionomics
Target of the concept *(explicitly defined by the creators of the concepts)*	Policy makers Policy institutions (OECD, UNCTAD, World Bank, EU-Commission, etc.) Policy analysts Scholars Practitioners	Businessmen Entrepreneurs Investors
Scope application area – (predominance)	Policy strategy	Business innovation strategy
Logic unit	Knowledge centric or information flows centric: Joint industry activities, public/private interactions, technology diffusion and Personnel mobility Relationship between technology, socio-economic structures and institutions Technological and economic performances Institutional set-up	Opportunity environment Business Centric Shared Purpose Platforms Supply systems Communities of destiny Expanding communities

3.6.2 Comparative analysis: Literature

The most striking difference between the terms IE and SI is their use in distinct subject matters. The SI articles are found in scientific journals devoted to the study of evolutionary economy and innovation economy. On the other hand, publications on the IE theories are predominantly found in journals focused on the study of competitive strategies in the management world.

Key author and key topics in SI – Christopher Freeman was an English economist, the founder and first director of Science Policy Research Unit at the University of Sussex, and one of the most eminent researchers in innovation studies (Toporowski et al., 2010). His fields of specialization were the economics of innovation and technical change. In 1986, on his formal retirement, he became visiting professor at the Aalborg University in Denmark. Freeman introduced the concept of National System of Innovation with B. Å. Lundvall and Richard Nelson (Lundvall, 2007b).

All three devoted their research on the following topics: technical change, science and technology indicators, the diffusion of technologies, structural change in the world economy and management of innovation.

Key author and key topics in IE – James F. Moore studies co-evolution in social and economic systems. He is best known for pioneering the IE theory to study networks of organizations (Steven, M., 2013).

Moore argues that IE is an essential unit of analysis for competition law, economics, sociology and management (Moore, 1996). His works involve an in-depth study of the multiple and interconnected nanoscience, semiconductors, systems-on-chips, global telecommunications services, smartphones and Internet-of-things devices, and app ecosystems (Moore, 2013). According to an analysis carried out on the works of the founding authors of both terms, much of the confusion arises from the fact that all of them have an interest in the study of innovation within a context of networks of relationships from an economic point of view. Yet another point of similarity is that the researchers of both IE and SI analyze the interactions between the actors involved in the systematic innovation process.

IE Cases – The creators of the terms IE and SI devoted their time on case studies related to their respective areas of research. Moore analyzed the technological strategies of companies such as Intel, Qualcomm, NVIDIA, Samsung, ARM Holdings, IBM, Apple, Facebook, Google, Microsoft and Amazon.

The main studies on the formulation of "IE theory" were based on a technological leadership study of the following companies: ABB Canada, Silicon Valley, Intel Corporation, Hewlet-Packard, Royal Dutch Shell Group and Sun Microsystems.

SI Cases – B. A. Lundvall, R. Nelson and C. Freeman studied the reality of the innovation process in specific countries. In 1987, Freeman published the book "Technology Policy and Economic Performance" on the development of the national innovation system in Japan. Nelson's studies focused on the USA (Dosi, 1988), while Lundvall (1985) focused on Europe. Table 3.4 presents this comparison from the literature perspective.

Table 3.4 : Comparative Meta-Synthesis Framework – Literature

Literature	***Comparative framework***	
	SI	**IE**
Seminal works	National systems of innovation: towards a theory of innovation and interactive learning (Lundvall, 1992)	Predators and Prey - A New Ecology of Competition (Moore, 1993)
Key authors	B. A. Lundvall, R. Nelson, C. Freeman	J. F. Moore, R. Adner, M.A. Cusumano and A. Gawer, M. Iansiti and R. Levien
Key topics	Theory of Innovation Interactive Learning	Strategy, Innovation, Leadership
Universities involved (research communities)	Aalborg University, Tsinghua University, SPRU (UK), Stanford University	Harvard University (Berkman Centre for Internet & Society), University of California – Berkeley, University of Cambridge (Cambridge Service Alliance)
Case	IKE-group, DISKO-project, NIS from Denmark, Sweden, Finland and Japan	ABB Canada, Silicon Valley, Intel Corporation, Hewlet-Packard, Royal Dutch Shell Group and Sun Microsystems

Table 3.4: Comparative Meta-Synthesis Framework – Literature

Literature	***Comparative framework***	
Authors who evolved the concept	Amable et al. (1997) Breschi et al. (1997) Carlsson et al. (1994) Edquist (2001) Fagerberg et al. (2004) Freeman (1987) Pavitt (1984) Nelson, R. et al. (1977) Whitley (1994)	Adner (2006) Gawer, A. (2012) Basole, Rahul C. et al. (2013) Battistella et al. (2013) Cusumano, M. A. et al. (2002a) Daidj (2010) Florian Urmetzer, Florian (2014) Fréry et al. (2012) Gueguen et al. (2004) Iansiti et al. (2002) Letaifa et al. (2013) Peltoniemi, M. et al. (2004) Rong, Ke et al. (2009) Teece (2015) Torre et al. (2015) Visnjic et al. (2012) Parisot et al. (2017b)
Heritage (historical emergence of the concept idea)	"The National System of Political Economy" (List, 1841)	"A Logic of Systems" (Angyal, 1941)
Some inspirations	**According to** Lundvall (2007b): Neo-Schumpeterian theories French structuralist Marxists Pavitt Taxonomy Interactive process inspired by research at SPRU Psychological pragmatist school of Chicago	**According to** Moore (1996): Inspired by Complex Systems Bateson's ecological Darwinist view Economic evolutionary theories of Nelson, R. et al. (1982) System thinking

3.6.3 Comparative Analysis: Framework

Considering the term *framework* as a set of ideas or facts that provide support for a theoretical structure, the meta-synthesis developed in Table 3.5 compares the essential elements that characterize the theoretical framework of IE and SI.

Scientific theory - In the analysis of technological innovation, there are many ways to represent the environment, actors and strategies. In the context of inter-company relationships, the cluster (El Sawy et al., 2013a, 2013b) and the network value (Rong, Ke et al., 2013a) models are the most used. IE distinguishes itself from these traditional models by also considering other network attributes, such as self-organization, emergence and co-evolution, which help to gain adaptability (Camarinha-Matos, 2009; Camarinha-Matos et al., 2010; Daidj, 2011). According to the OECD (1997), SI is geographically centered, and performs surveys and cluster analysis. With respect to IE, "A business ecosystem goes beyond the core business agents (direct suppliers, core contributors and distribution channels) to embrace the whole supply chain, as well as other indirect agents and stakeholders."

Core discipline and theoretical basis – IE is predominantly found in publications focusing on management and technology concepts (complex systems), while SI has a strong presence in publications focused on economic theories (learning economy and knowledge economy). As postulated by the original contributors, both IE and SI are applications of System Thinking (Rakas et al., 2016). Both theories commonly involve the analysis of three aspects: the understanding of innovation activities, the role of the agents involved, and the interaction and resulting networks between them.

Boundaries and network boundaries - The aspect of regional localization is a relevant factor for the SI theory (Niosi et al., 1993). There are three ways in which we can identify boundaries of SIs: spatially/geographically, sectoral and functionally (Edquist, 2001). In the IE theory, virtuality is a fourth accepted facet. As with a biological ecosystem, the main attribute of an IE is the heterogeneity of the actors, who pursue different objectives with different strategies. Interactions within an IE can be identified and classified in several ways, depending on the interests (shared purpose), the strategies of collaboration, shared resources and capacities involved; they are therefore complex and dynamic (Letaifa et al., 2013; Moore, 2013). The networks analyzed in the

SI theory are found into two classes: the network of institutions in the public and private sectors (Freeman, 1987). The IE theory, on the other hand, considers networks as any business that is evolving in collaboration (Adner et al., 2013; Moore, 2013).

Industry role - One of the most striking differences between the two theories is the role of industry-level analyses. In the SI theory, industry segments are important actors in the transformation of scientific knowledge into products and services (Lundvall, 2007b). In the IE theory, the industry segment does not have any role *per se*, and the segments are not units of analysis (Moore, 1996). Instead, the IE theory measures the individual relationships among the players (Thompson et al., 2012), which, in some cases, are clustered within a specific industry segment, though not necessarily.

Table 3.5 : Comparative Meta-Synthesis Framework - Framework Structure

Framework	***Comparative framework***	
	SI	**IE**
Scientific approach	Grounded Theory (Lundvall, 2005)	Grounded Theory (Letaifa et al., 2013)
Core discipline	Economy	Management
Theoretical basis	Learning economy	Complex Systems
	Knowledge economy	System Thinking
	Evolutionary economy	Resource-Based Theory
	System Thinking	Evolutionary economy
Boundaries (the firm's perspective)	Sub-regional, national (most relevant),	Global
	Pan-regional and International	
Network boundaries	The network of institutions in the public and private sectors	One business collaboration agreement in a complex arrangement without borders; may include competitors
Industry role	An important protagonist in the transformation of scientific knowledge into products and services	The concept of industry is irrelevant and outdated
Approaches to analyzing	Firm-level innovation surveys	Network effect
	Cluster analysis and	Network value
	Patterns of knowledge flows	Shared Purpose
		Value Co-creation
		BEAM (business ecosystem analysis and modeling)
		Value creation in innovation ecosystems
		Constructs, Configurations, and the Nurturing Process

3.6.4 Cross-fertilization between the theories

As it is evident from the previous analyses in this paper, SI and IE were developed within quite different contexts, and therefore they aim at explaining different dynamics. SI was developed mainly in the context of traditional manufacturing and incremental learning via SDI and DUI. We have a capital-intensive infrastructure in place and wonder how to design institutions that facilitate such learning processes. In IE, however, we look at San Francisco Bay Area dynamics within very dynamic and young industries, and also a novel and rapidly changing technology landscape (SFCED, 2015). In that way, we can see potential complementarities with respect to adjusting SI to new economic paradigms. In this article, other elements of complementarity have been identified and will be analyzed, but for this it is necessary to return to the objective of this article and to specify how the proposal of cross fertilization was developed: the main aim of the paper is to clarify to what extent the SI and IE literature are complementary and could benefit from cross-fertilization.

The purpose of this cross-fertilization is to identify interactions or interchange that are mutually beneficial and productive for both theories. In order to enable this cross-fertilization, a comparative analysis was developed according to the theoretical framework (Table 3.6) that composes each theory. Seminal articles, founding authors and major research communities were studied and compared. From the elements in common, a set of propositions of cross fertilization was elaborated considering three key elements: the interactions, the evolutionary theories and the building blocks of each theory.

Cross-fertilization: interactions

The results of the comparative analysis show reciprocity between the two theories regarding the understanding of the phenomenon of innovation when its dynamic elements (actors or processes) are analyzed according to their interactions. These interactions occur in a scenario common to both theories: technological change in environments conducive to innovation. In this way, the interactions can constitute a cross fertilization link in both theories. First, in IE theory the concept of interaction requires a more structured definition that could be improved by inserting the concept of learning economy through the knowledge flows coming from the theory of innovation systems. On the other hand, the idea of institutional relationships coming from SI is based on the logic of economic geographic performance and lacks the understanding of more complex environments

contemplated in IE. An example to be adapted in SI theory would be the possibility of understanding the effects of interactions in a context based on technological platforms that are not limited to regional or national borders.

Cross-fertilization: evolutionary theories

Evolutionary economics is part of mainstream economics as well as a heterodox school of economic thought that is inspired by evolutionary biology (Hodgson, 1993; Hodgson et al., 1994). Evolutionary economics deals with the study of processes that transform the economy for firms, institutions, industries, employment, production, trade and growth within, through the actions of diverse agents from experience and interactions, using evolutionary methodology (Simandan, 2012). Both theories use hypotheses based on evolutionary theories. One of the points where SI could benefit from IE's fundamentals would be the adoption of a variable of understanding (hypotheses) of innovation strategies in collaborative networks (best practices) in a global context and not restricted to geographic regions. This variable would seek to identify actors and networks of collaboration (external to the geographic area) with the power to influence the national or local innovation scenarios and consequently the impact on the policies on the agenda. From the point of view of IE, the influence of political actions is practically ignored. The adoption of analyzes of government actors as support for the expansion of *innovation communities* would be a major contribution of IS to IE theory. Moreover, new economic paradigms such as Virtual currencies, FinTech, Crowdfunding and others, are analyzed through perspectives of IE and may contribute to the evolution of the theoretical-conceptual framework of SI.

Cross-fertilization: building blocks

In the comparative analysis of the scientific constructs (building blocks) of IE and SI, it was noted that both use the methodology known as Grounded Theory. According to Glaser (1992), the strategy of Grounded Theory is to take the interpretation of meaning in social interaction on board and study "the interrelationship between meaning in the perception of the subjects and their action". Another goal of a grounded theory is to discover the participants' main concern and how they continually try to resolve it. The questions the researcher repeatedly asks in grounded theory are "What's going on?" and "What is the main problem of the participants, and how are they trying to solve it?" (Glaser, 1978).

Grounded theory researchers are interested in patterns of action and interaction between and among various types of social units (i.e., "actors"). IE and SI theories have as a common factor the study of the phenomenon of innovation and its actors. IE and SI seek from different perspectives to understand and contribute to the challenges of innovation as a permanent element in the socio-economic and technological scenario. Although they have different starting points and objectives, they both start from the same methodological construction process and, using the same lenses, can integrate their research communities in seeing and constructing their theories. In the context of SI theory, it is important to note that the concepts of governance, resilience, power generation, coopetition and competition are not particularly well-developed in SI, and their consideration might be a fruitful path for SI theory improvement, inspired by IE.

Table 3.6 : Comparative Meta-Synthesis Framework - The interaction between theories

Concepts	**SI**	**IE**
Key concepts	"...The elements and relationships which **interact in the production, diffusion and use of new, and economically useful, knowledge** ..." Lundvall (1992)	"An economic community supported by a foundation of **interacting organizations and individuals** — the organisms of the business world" Moore (1993)
Logic unit	Technological and economic performances	Opportunity environment Platforms
Literature (sources)	**SI**	**IE**
Key topics	Innovation	Strategy, Innovation
Inspirations	According to Lundvall (2007b): Neo-Schumpeterian theories	Economic evolutionary theories of Nelson, R. et al. (1982)
Framework	**SI**	**IE**
Scientific approach	Grounded Theory (Lundvall, 2005)	Grounded Theory (Letaifa et al., 2013)
Theoretical basis	Evolutionary economy System Thinking	Evolutionary economy System Thinking

Other results of this research show possibilities of cross-fertilization through some initiatives that require the understanding of some contexts that will be detailed below.

In SI, we find several articles showing a mature self-criticism in search of improvements. As an example, we have the article "National innovation systems - analytical concept and development tool" that deals with the maturity and applicability of the theory in empirical terms. On the other hand, we have in IE an emerging theory that is more focused on the development of two types of research:

- The proposal of analytical tools developed for processes of strategic decision (Ecosystems Value Mapping and Analysis – Cambridge Service Alliance) or for operability of projects of technological innovation (6C Framework – Cambridge University),
- The deepening of the epistemological and ontological bases for the scientific justification of its originality in terms of school of thought. The works developed in Cambridge and by the *French school of IE* (Parisot et al., 2017b) in the article “Une lecture Lakatosienne de l’approche par les Ecosystemes d’affaires” have shown commitment in research in the thematics of IE.

In terms of academic production, this research has shown that the number of case-study publications in IE are still few in number compared to SI studies analyzing innovation systems in each country. It would be interesting to evaluate if the cluster analysis used in SI can be a source of inspiration for IE research.

A similarity was found showing that these two different theories are applications of System Thinking approach. Another finding, which has not been mentioned in previous research on the topic, is that the construction of the initial concepts of the IE theory is originally rooted in several SI elements.

A research agenda focused on the analysis of cross citations between articles of the two communities was also identified as a source of responses to identify cross-fertilization benefits.

3.7 Conclusions

The results of this research were presented in the item "Cross-fertilization between theories" and non-exhaustively presented the numerous opportunities of cross-fertilization between the theories that were compared and analyzed.

Based on a review of literature, the analysis of each theory was developed on an ontological framework built from the meta-synthesis technique integrating the seminal results of the theories that were compared. The choice of methodology was to identify conceptual terms as a central reference and to build an ontological framework in order to adapt to each theory in a well-structured way.

The meta-synthesis was an ideal choice since the theories under study were constructed under the logic of Grounded theory, the concepts and categories of which are well established. In this way it was possible to clearly visualize the strengths of the chosen methodology.

The comparative analysis between the theories included in the above inventory (Table 3.3, Table 3.4, Table 3.5 and Table 3.6) were made on many aspects, varying from ontological concepts (logic unit, key concepts, related terms, etc.) to formal structure (scientific approach, theoretical basis, approaches to analyzing, etc.) and including the major research communities (Harvard University - Berkman Centre for Internet & Society, University of California – Berkeley, University of Cambridge - Cambridge Service Alliance, Aalborg University, Tsinghua University, SPRU (UK), Stanford University).

Numerous difficulties were encountered in the course of the research. Distinguishing which papers used the term ecosystem as metaphor or as Moore's theory was a great challenge. Soon after, several articles were identified quoting Moore and his theory but disregarding all the framework and existing theoretical elements. Numerous were those articles mixing theory and metaphors. In the context of SI, the difficulty was to identify more recent articles in the subject, since the number of publications in the subject is decreasing.

Finally, cross-fertilization analysis was performed observing similar and interactable elements.

Suggestions and practical applications

In the course of this research, many factors were identified as potential elements for a possible continuity of cross fertilization research.

These reflections and practical propositions are the result of the analysis and the identification of an opportunity to evolve concepts and correlations that await a deepening of this research that is potentially rich in answers. In this way, we conclude proposing a trajectory to be followed to deepen this research:

- A research agenda can be proposed by identifying gaps to be filled between the two theories as well as an analysis based on other comparative methods;
- Opening to the intersection of theories in conferences and other events of research communities;
- Development of collaborative works among the researchers in the subject;
- Improve the policy making process by incorporating IE's dynamic business and market vision
- Elaborate a study of trends in innovation, observing the socio-economic and technological aspects for a new cross-fertilization according to the current needs;
- Elaborate case studies to identify empirical results and limitations in the case of attributes resulting from cross-fertilization

Limitations - We were exposed to some limitations in this paper. Other aspects could be used to compare the theories under study, but without a structured criterion through the proposed framework, we run the risk of not prioritizing what is essential in a literature review.

CHAPTER 4 – RESEARCH DESIGH AND METHODOLOGY

4.1 Research questions and objectives

Qualitative research is conducted through key research questions (Jonker et al., 2010), which are the foundations for the formulation of hypotheses along the research (Ackerson, 2007; Jonker et al., 2010; Stringer, 2007). Having this in mind, in this proposal some questions are enounced to serve as the guideline for the research. Based on the systematic review of the literature of the previous chapter, the thesis proposes to address the following general research question:

How can companies assess their competitive environment taking into account today's innovation strategies?"

The thesis aims to answer three research questions. The following research sub-questions are therefore considered (each representing an objective of the thesis):

1. **Which elements constitute the theoretical basis for an assessment based on the perspective of innovation ecosystems?**
2. **How can the innovation ecosystem assessment be integrated to technology strategies at the firm level?**
3. **What is the dominant logic, constructs, and methods for assessing an innovation ecosystem at the firm level?**

4.2 Research objectives

The objectives of the research presented in this thesis are enunciated as follows. To each objective, the sub-items that follow anticipate the activities and results that are connected to them.

Objective 1: To assess the "state of the art" of the IE theory through the comparative analysis related to another theory already established i.e. National System of Innovation theory. This systematic review establishes the coherence and theoretical foundations necessary to achieve the research objectives **(article 1).**

a) Through the analysis of the most relevant and extensive biography on the subject, this systematic review takes stock of the theory (scientific approach, definition, typology, terminology, constructs, scope, logic unit), but also the practice (best practices, industry role, boundaries, approaches to analyzing).

b) Proposition of cross-fertilization between some common elements found benefiting both research communities i.e. IE and SI.

Objective 2: Identify previous research and tools on assessing IE and with the results found propose an approach for strategy thinking and decision-making at the firm level, which uses roadmapping[4] as an integrating "hub" and is enriched by the assessment of the surrounding IE **(article 2).**

a) Identification gaps of existing IE tools through a critical analysis of tools available in the literature, in what concerns their actual application for the assessment of strategies at the firm level.

b) Development of three case studies with Canadian hi-tech startups which provide products or services in the Internet of Things, Smart Home and Big Data analytics domains.

c) Proposition of an approach to integrate IE assessment to the roadmapping toolkit.

d) Presentation of results on evaluating the feasibility of the approach in case studies.

Objective 3: Based on the findings of previous research and the identification of the dominant logic in the IE, this research objective aims to propose and test an analysis toolkit for IE assessment to support other forecasting tools for strategy analysis and decision-making at the firm level **(article 3)**.

[4] In the literature, the terms "technology roadmap," "technology roadmapping," "roadmapping" and "TRM" are used interchangeably. In this paper, the term "roadmapping" is used to refer to all these terms.

a) Development of multiple case studies of technology companies in the fields of the urban mobility and Unmanned Aerial Vehicle (UAV) industries. Within each case study, the IE assessment toolkit was applied for testing purposes.

b) Identification and analysis of the dominant logic for assessing IE, its constructs and related means for assessing an innovation ecosystem.

c) Presentation of a conceptual support analytical framework (Value Framework) aiming to relate the value analysis with the most relevant themes – IE variables – and their respective subthemes found in the literature (Boschma, 2005; Täuscher et al., 2018).

4.3 Research organization

The following Table 4.1 presents the organization of the thesis by article. In total, four articles, three published and one submitted, make up the thesis.

Table 4.1 : Organization of the thesis by article

	Article 1 – JEE	*Article 2 – IEEE TEM*	*Article 3 – TFSC*
Title	Systems of innovation and innovation ecosystems: a literature review in search of complementarities.	Integration of technology roadmapping and innovation ecosystem assessment for open strategy design: a proposal based on in-depth case studies.	Assessing innovation ecosystems strategies at firm level - Proposal and test of a toolkit through case studies
Research questions	Which elements constitute the theoretical basis for an assessment based on the perspective of IE?	How to integrate the IE assessment for technology strategies at the firm level?	What is the dominant logic, constructs, means for assessing an IE at the firm level?
Key concepts	Systems of Innovation, Innovation Ecosystems, Theoretical constructs, Strategy.	Innovation Ecosystems, Technology Roadmapping, Open Strategies, Technology Strategy.	Innovation Ecosystems, Assessing Innovation Ecosystems Strategies, Foresight Toolkit.
Research goals	To discover the state of the art of the IE theory through the comparative analysis of two relevant theories.	Identify previous research and tools on assessing IE. Proposition and test of an assessment approach in the context of IE.	Propose an analysis toolkit for IE assessment to support other forecasting tools for strategy analysis and decision-making at firm level.
Publication status	Published in the "Journal of Evolutionary Economics" (2018)	Submitted and Accepted by "IEEE Transactions on Engineering Management" (2019)	Submitted to the journal "Technological Forecasting and Social Change" (2019)

4.4 Methodology

Theories and methodologies strongly support a research project by allowing a study's validity to be evaluated. Systematically designed research challenges old beliefs and produces new theories, for this reason, research must be based on logical and systematic procedures. In this sense, research methodology is the rationale behind a collection of concepts, ideas, theories, and assumptions, and it is required to show how the research theory and methodology are selected (Yin, Robert K., 2009). In order to select the research methodology, it is necessary to consider which theories will be adopted, which materials will be used, how the data was prepared for the study, the research protocol, and how the data was analyzed (Creswell, 1999). In this way, it is necessary to select an appropriate research approach before starting data collection. Vukojević (2016) described three research approaches: quantitative, qualitative, and mixed methods. In line with the objectives of this research our approach to research is quantitative.

4.4.1 Qualitative Method Strategy

Quantitative research is a research method that reveals relationships by presenting and analyzing evidences. Many researchers have produced summaries of the various types of quantitative research. As such, there exist a variety of strategies in quantitative research like: adopting narrative research, phenomenological approach, case studies approach, grounded theory, ethnographic approach and others (Creswell, 1999).

The strategy chosen in the context of this research were (1) design science research methodology and (2) case studies analysis supported by literature reviews using the following approaches (1) meta-synthesis literature review (systematic comparison) and (2) qualitative evidence synthesis. The chosen methodologies are applied and characterized as follows Figure 4.1:

- **Phase 1** - Meta-synthesis is a non-statistical technique used to integrate, evaluate and interpret the findings of multiple qualitative research studies (Cronin et al., 2008; Zimmer, 2006) that involves analyzing and synthesizing key elements of each concept, based on the identification and analysis of seminal works transforming individual findings into conceptualizations and interpretations (Polit et al., 2014).

- **Phase 2** - The Design Science Research studies the creation of artifacts and their embedding in physical, psychological, economic, social and virtual environments (Bayazit, 2004; Sordi et al., 2015) and they may, for example, be a method, a process, a questionnaire, an approach, an analytical formula, or a scale for classification.

- **Phase 2, 3 and 4 -** Case studies analysis is widely used in organizational studies and across the social sciences. According to Yin, R. (2003, p. 2) "the distinctive need for case studies arises out of the desire to understand complex social phenomena" because "the case study method allows investigators to retain the holistic and meaningful characteristics of real-life events," such as organizational and managerial processes. The choice of this analysis model is due to the need to discover theory by directly observing a social phenomenon in its natural form (Yin, Robert K, 2011). In answering our research question, we aim at enriching existing theory with new insights from real-world cases (Eisenhardt, K. M., 1989), In setting up a *multiple case study approach*, we defined a sampling frame of criteria associated with the theoretical background and research interest of our study. We sought to select companies that (1) are part of relationship-intensive innovation ecosystems as well as (2) rich in emerging technologies such as smart home, smart urban mobility and IoT. Another criterion considered was (3) the need to find companies with their stable business model, that is, with their services or products already established in the market and (4) not limited to traditional industries. The previously collected data were validated during semi-structured interviews conducted in the format of workshops and later transcribed analytically in chapters 5 and 6 of this thesis. In addition to the interviews, documents were utilized as secondary material in the research. Because documents typically have broad coverage (e.g. long period) and can provide exact information on many events and settings, the evidence collected from the interviews with the case company representatives was complemented by relevant documentation.

- **Phase 3 and 4 -** Qualitative evidence synthesis methodology is recognized as providing credible and useful material to address practical issues with a pragmatic view (Bohren et

al., 2014; Hannes et al., 2011a), scanning for ‘constructs’ across multiple studies (Grant et al., 2009; Karimi-Shahanjarini et al., 2019).

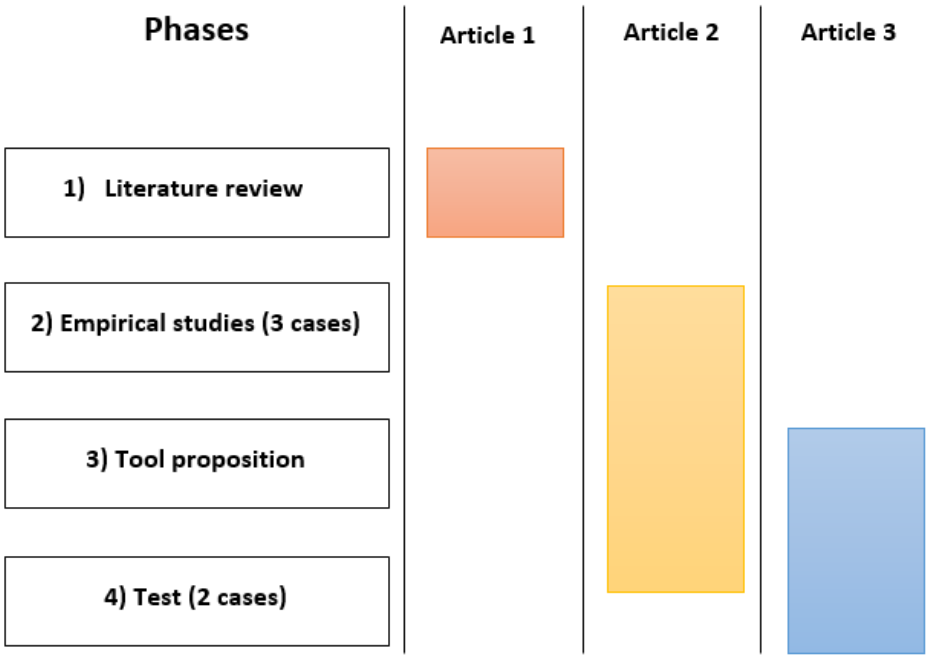


Figure 4.1 : The chosen methodologies by phases and articles

Still, according to the nature of the research it is characterized by an exploratory and multidisciplinary research since search across multiple disciplines to solve specific problems (Ackerson, 2007).

Although a methodological justification is developed within each of the articles that make up the thesis, the following subsection summarizes each of the research designs used.

4.4.2 Summary of methodologies used by article

The following Table 4.2 shows the different methodologies used in each article. In each case, the key literature of the methodology in question, the unit of analysis considered, but also the data used are specified.

Table 4.2 : Summary of methodologies used by article

	Article 1 – JEE	*Article 2 – IEEE TEM*	*Article 3 – TFSC*
Main objective of the article	To discover the state of the art of the IE theory	Identify previous research and tools on assessing IE	Propose an analysis toolkit for IE assessment
Methodology	Meta-synthesis literature review (systematic comparison)	Design Science Research (DSR) methodology and case studies analysis	Qualitative evidence synthesis and case studies analysis
Key methodological reference	(Cronin et al., 2008) and (Ackerson, 2007)	(Blessing et al., 2009) and (Bayazit, 2004)	(Grant et al., 2009) and (Hannes et al., 2011b)
Unit of analysis	System Thinking and theories in the field of Innovation	Value Stream (creation and capture)	IE Building blocks (constructs)
Typology of data (Springer-Nature classification)	131 documents (scientific articles, conference papers, conference proceedings, thesis, books, government documents, reports and journal articles)	132 documents (scientific articles, conference papers, conference proceedings, thesis, books and journal articles)	87 documents (scientific articles, conference papers, conference proceedings, thesis, books, government documents, reports and journal articles)
Sources of data	Engineering Village, Springer-Nature, ScienceDirect and Google Scholar.	Springer-Nature, ScienceDirect and Google Scholar	Engineering Village, Springer-Nature, ScienceDirect, ResearchGate and Google Scholar.

CHAPTER 5 ARTICLE 2: "INTEGRATION OF TECHNOLOGY ROADMAPPING AND INNOVATION ECOSYSTEM ASSESSMENT FOR OPEN STRATEGY DESIGN: A PROPOSAL BASED ON IN-DEPTH CASE STUDIES"

> "The new management is about working smarter rather than harder. It's not about doing more work in less time: It's about generating more value form less work" – (Denning, 2018)

5.1 Presentation of the article

The article presented in the chapter 4 of the thesis (article 1) made it possible to identify the "state of the art" of the innovation ecosystem theory. Several suggestions for future research emerged from this work, each of which aims to contribute to a better understanding of the theory and its associated subjects. Among the findings it was possible to identify a gap to be filled regarding the development of analytical tools, however, before any instrumental proposition in terms of tools it is necessary to identify which logic is dominant in terms of strategic design, in other words, we need to identify which heuristic is currently used by decision makers. This is one of the objectives of this article. Also, this paper identifies the mode of integration between the perspective of IE and technological strategy tools through an artifact-based approach. Through multiple case studies, the approach was tested by identifying empirical elements relevant to the research objectives. Some constructs supporting the creation of a tool are identified and serve as a fundamental input for article 3, which aims to propose a tool in a structured way.

The article entitled "*Integration of technology roadmapping and innovation ecosystem assessment for open strategy design: a proposal based on in-depth case studies*" is co-authored with Fabiano Armellini. It has been selected for submission for the special edition on "New Perspectives on Roadmapping" of the Journal IEEE Transactions on Engineering Management, after approval of

its abstract on 10 December 2018 by the guest editors. The full paper has been submitted on 22 July 2019 and is currently under review.

Abstract

The objective of this article is to propose an approach to integrate innovation ecosystem (IE) assessment with strategy thinking and decision-making, using roadmapping as an integrating "hub." Our hypothesis is that this integration is a fruitful (if not indispensable) path for the design of open strategies, which examine how companies enhance strategy formulation that effectively integrates open innovation. This proposal is obtained through a Design Science Research (DSR) methodology comprised of a comprehensive literature review, three preliminary empirical case studies, an artifact proposal, and two subsequent case studies for testing and analyzing the proposal. Our findings indicate that although roadmapping architecture is flexible in the use of organizational hierarchies, especially in firm-centered logic, it requires adjustments for the development of inter-organizational models centered in networks where open strategies rely on emerging technology whose development is collective and network-centered. The integration of IE assessment tools seems to be an obvious choice to counter this deficiency. However, we found that existing tools are overly complex, provide little or no visual support and are not very intuitive. Our proposition aims at solving both deficiencies for an effective integration of IE assessment and roadmapping.

Keywords

Innovation Ecosystems, Technology Roadmapping, Open Strategies, Technology Strategy.

5.2 Introduction

Today's business environment reward agility where strategies are emergent, opportunistic and flexible (Youngblood, 2000). In this respect, while traditional and consolidated strategic models (such as value chain) and more innovative models (such as value network and value ecosystem) focus on the process of value creation, the innovation ecosystem (IE[5]) model analyzes and underlines the value of the relationships amongst actors and the key elements (physical structure, revenue attraction, attractiveness, assets and technologies) that foster ecosystem survival and development (Battistella et al., 2013). The IE theory is still in its conceptualization phase in which new models of understanding are being developed, tools are being proposed and research agendas and groups are being created (Rong, Ke et al., 2015c). Nevertheless, this theory is gradually finding its place in the literature, as it is being differentiated from contiguous theories and concepts, such as that of systems of innovation (Faissal Bassis et al., 2018; Torre et al., 2015) and (Peltoniemi, M., 2014). Moreover, several theoretical cross-disciplinary concepts, which stretch it far beyond a mere ecological metaphor for strategy thinking (Adner et al., 2010; Gawer et al., 2014; Gawer, A., 2014), have been developed within the IE theory in the last decade. Among the literature being constituted around the constructs of the IE, we find case studies on the subject (Li, Y.-R., 2009, 2011; Wei et al., 2007; Weil et al., 2014), validation of the IE theory (Parisot et al., 2017a, 2017b; Rong, Ke et al., 2015c), identification of the ontological constructs (Adner, 2017; Faissal Bassis et al., 2018; Gomes et al., 2016) and the life cycle of an ecosystem (Rong, Ke et al., 2015c), key features of an IE (Peltoniemi, Mirva, 2006; Piepenbrock, 2009; Vuori et al., 2004), proposals of

[5] In the literature, the terms “Innovation Ecosystem” and “Business Ecosystem” are used interchangeably. In this paper, the term “Innovation Ecosystem” (IE) is used to refer to all these terms.

models for strategy orchestration (Valkokari et al., 2017), IE governance (Ayrikyan et al., 2012), and efforts to integrate the IE to open innovation (Bogers et al., 2017; Chesbrough et al., 2014; Wulf et al., 2016). Although the advancement of research in the field of theory has shown fruitful results, a large gap remains to be filled in the proposal of application tools in the field of praxis. Thus, this article proposes an approach for strategy thinking and decision-making at the firm level, which uses roadmapping[6] as an integrating "hub" and is enriched by the assessment of the surrounding IE. A striking difference in the proposed approach is the assessment of strategies based on value analysis.

To achieve this aim, the remainder of this article is structured as follows, according to the AIM(RaD)C convention (Cargill, 2009). Section II presents our research methodology, followed by an analysis of the current literature pertinent to our proposal in Section III. Sections IV and V discuss empirical case studies aimed respectively at filling the gaps found in the literature and building empirical knowledge for the proposal of the IE approach. Section VI examines the applicability of the proposed approach and section VII presents our conclusions.

5.3 Methodology

This research approach is based on Design Science Research (DSR) methodology. DSR studies the creation of artifacts and their embedding in physical, psychological, economic, social and virtual environments (Bayazit, 2004; Sordi et al., 2015). There are many possible forms of artifacts to be developed in the field of innovation strategies. They may, for example, be a method, a process,

[6] In the literature, the terms "technology roadmap," "technology roadmapping," "roadmapping" and "TRM" are used interchangeably. In this paper, the term "roadmapping" is used to refer to all these terms.

a questionnaire, an approach, an analytical formula, or a scale for classification (Blessing et al., 2009). In this research, the artifact to be proposed follows the "approach" typology and will be designed according to the DSR framework (Fig. 5-1).

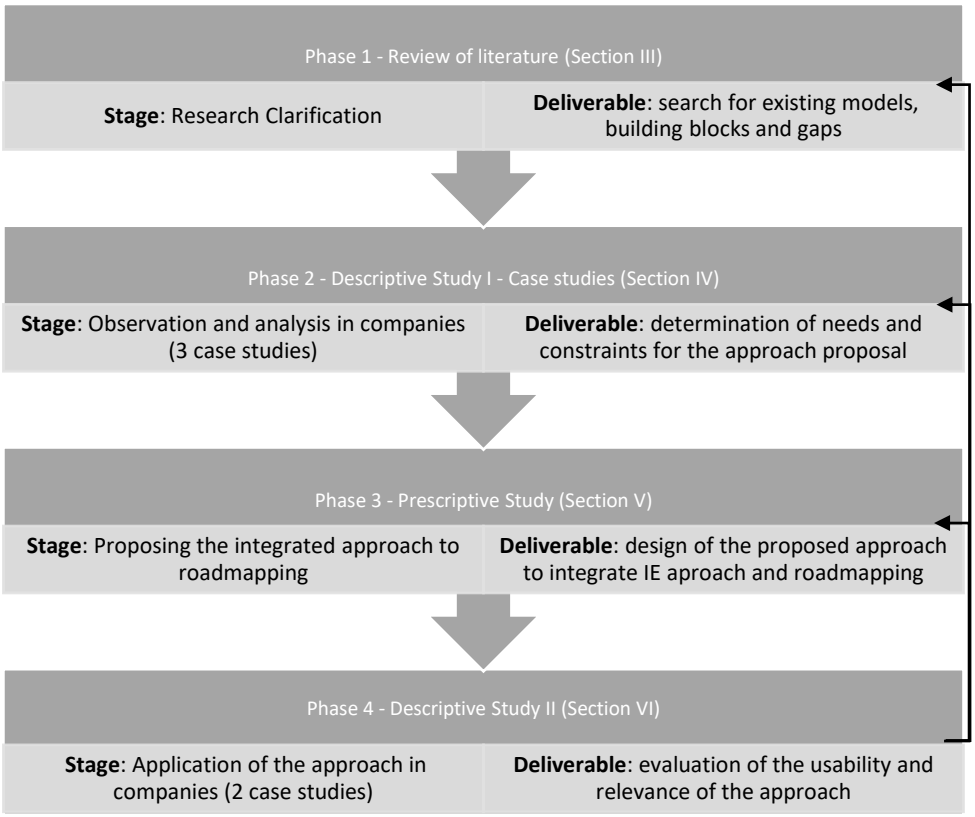


Figure 5.1 : DSR framework and research methodology

The literature review (Phase 1) is intended to identify the practices of integrating other concepts and approaches to roadmapping as a path for the assessment of strategic landscapes within the IE context. We thus adopted a literature review approach based on an extensive qualitative evidence synthesis, which consists in the use of a selective sampling as the source of previously inventoried literature on the subject (Grant et al., 2009; Phaal, 2018). This literature review also aims to identify gaps in existing IE tools as concerns their actual application for the assessment of strategies at the firm level.

The first descriptive study (Phase 2) comprises three case studies with Canadian hi-tech startups that provide products and or services in the Internet of Things, Smart Home and Big Data analytics domains. These companies were selected because of their complex innovation ecosystems, characterized by convergent technology platforms and multi-sectoral interest in their solutions. In the first case study, a renowned technology roadmapping method was applied to perform an empirical analysis on how other concepts could be integrated to roadmapping. In the second and third cases, we performed a comparative analysis of different IE assessment tools to determine their strengths and weaknesses with a view to their eventual use for strategic thinking and decision-making at the firm level. Throughout all three case studies, performed through intervention research (Cappelletti, 2010), the research team searched for complementarities and opportunities for the integration of IE assessment and roadmapping through field observation, timely interventions, and structured interviews and surveys with workshop participants.

Phase 3 (prescriptive study) – a normative context – presents the method proposed to integrate IE assessment to the roadmapping toolkit. The conception of the logic of integration with the intended approach to roadmapping is based on the essential references on the subject (Kerr et al., 2013; Kostoff et al., 2001; Lee et al., 2005; Phaal et al., 2003; Willyard et al., 1987), as well as on the gaps noted in the literature review. Subsequently, with the empirical support of three case studies, a set of practices and necessary steps were identified to design (Eppinger et al., 1995) the intended approach. Finally, the second descriptive study (Phase 4) presents the results on evaluating the feasibility of the approach in two cases studies.

5.4 Theoretical background

We divided the analysis of the current literature pertinent to our proposal into two parts. In the first part, we identify the existing practices for integrating different contextual concepts and approaches to roadmapping. In other words, this first part aims to identify the possible interfaces of integration between tools, methods and techniques with roadmapping. The second part of the literature review presents a comparative study of different IE tools to identify the gaps in the assessment of strategies in a value-thinking context within an IE.

5.4.1 Previous research on roadmapping and types of integration to other tools

As mentioned in Section II, a sample of publications inventoried by Phaal (2018) was used as a source of analysis, which comprises 962 studies on roadmapping over a 31-year period, from 1987 to 2018, including conference papers, theses and articles. An initial cursory analysis of these articles, performed by reading their titles, journal names, abstracts and introductions, revealed that not all the articles identified would be useful for our purposes since not all articles deal with the integration between the roadmap and other tools. In this first analysis, we identified 79 articles that were potentially interesting, but not necessarily directly linked to the objectives of this literature review. To identify relevant articles for our specific purpose, we applied two exclusion criteria. The first is that the publication should deal with the integration of roadmapping to other subjects in a nontrivial and nonmarginal way. The second is that the publication should refer to the "integration process" as a concept related to roadmapping integrated to other tools or approaches. After filtering, our remaining database consisted of 28 publications. Through the in-depth reading of these 28 articles, we became aware of further works on roadmapping integrated to other tools that appeared highly relevant and that we thus decided to include in our review. Our remaining database consisted of 33 publications. We decided to eliminate conference papers that had already

been identified in previous journal papers, which left us with a final sample of 30 articles. In these publications we found three types of integration to roadmapping: (1) normative approaches, (2) contextual approaches and (3) roadmapping customization. Table 5.1 below summarizes the types of integration and the tools that were integrated to roadmapping according to the 30 publications analyzed.

Table 5.1: Identified tools and typology of integration

Typology of integration - approaches	Tools integrated to roadmapping
Normative approaches *(analytical tools, process modeling, methods, standards, best practices, scientific approaches)*	TRIZ (Ilevbare et al., 2011), QFD (An et al., 2008), DMSMS-driven design refresh planning (Myers, 2007), Delphi method (Kanama et al., 2008), Fuzzy PROMETHEE' (Ghazinoory et al., 2014), Bibliometrics models (Li, X. et al., 2015; Liao et al., 2016), Risk assessment methodologies (Koivisto et al., 2009), Integrated management model (Lopez-Ortega et al., 2006; Saritas et al., 2004), Integrated technology monitoring and assessment tools (Koivisto et al., 2009), Methods for supporting scientific research (Yan et al., 2005)
Contextual approaches *(conceptual models, conceptual framework, information grids, forecast trends, gap analysis, tables, matrices)*	Quality gates (Giebel et al., 2009), Project portfolio management (Oliveira et al., 2010), Business modeling (Abe et al., 2009; Hitoshi et al., 2008), Ecosystem-based approach (Wesselius et al., 2007), Open collaboration (Bicking et al., 2011; Lichtenthaler, 2008), Decision making and marketing tools (Fenwick et al., 2009), Value-creation perspective (Komssi et al., 2011), Technology intelligence approaches (Lopez-Ortega et al., 2006), Business model canvas (Toro-Jarrín et al., 2016)
Customizing roadmapping approach *(roadmapping customization)*	Roadmapping customization (Hirose et al., 2015; Kerr et al., 2013; Phaal, 2019; Phaal et al., 2006a; Phaal et al., 2003; Phaal et al., 2009; Robert Phaal et al., 2000)

This analysis highlights roadmapping's flexibility and versatility in integrating with other tools, which allowed us to propose a classification or typology of different ways to integrate roadmapping to other concepts or tools.

"Normative approaches" set conditions for what is considered good or normal. In other words, when we take a normative approach, we are not just describing how things are, we are making assertions about how things ought to be. Assertions include "requirements," "recommendations," "protocols" and "statements." In this literature review, we found the following types of normative integration: analytical tools, process modeling, methods, standards, best practices and scientific approaches.

Since integrations based on "contextual approaches" are characterized by a high level of differentiation appropriate to very specific contexts or scenarios, each identified case has its own characteristics. The integration interfaces were in fact a collection of data being used as inputs in the domains (layers) of roadmapping analysis. Characterized by conceptual or contextual attributes of the scenario, these integrations are concentrated in case studies in the current literature. In this type of integration, it is usually hard to find a pattern that can be replicated in a different context. In our analysis, we found the following interfaces of integration within this typology: conceptual models, conceptual frameworks, information grids, forecast trends, gap analyses, tables and matrices.

The integration approach focusing on "roadmap customization" is based on a set of steps and compliance with certain principles. The premise underlying this approach is based on the following assertion "…if roadmapping is to be applied effectively then it is essential the approach be adapted to fit the particular circumstance of interest" (Phaal et al., 2003). In the search for a more accurate understanding of this type of approach, we find a vast literary support indicating contexts and forms

of integration (Phaal et al., 2000; Phaal et al., 2006b; Robert Phaal et al., 2000), procedures in the process of integration (Phaal, R. et al., 2011; Phaal, R. et al., 2011; Shehabuddeen et al., 2006), and best practices (Keer et al., 2015; Phaal et al., 2016). The identified literary support also includes case studies considering empirical aspects of roadmapping customization (Phaal et al., 2003; Shehabuddeen et al., 2006), its principles (Martin G. Moehrle, 2013) and its architecture (Robert Phaal et al., 2000). In a deeper analysis of the architecture of roadmapping, we find an important link between the IE approach and the possible contextual inputs to roadmapping. This link is the "business environment" analysis because it is a common theme between IE (Moore, 1996) and roadmapping (Strauss et al., 1998; Suomalainen et al., 2011) and, therefore, an opportunity to be explored for our proposed integration.

Based on these findings and in the context of this research, we decided to use the third typology − "roadmapping customization" − as our reference for this paper since we identified more literary support, proposals of principles, and numerous case studies with empirical examples. This decision was also mainly based on the flexibility of contextualization of a fluid IE approach within the domains of knowledge required that make the integration more robust and consistent.

5.4.2 Previous research on assessing innovation ecosystems

In the last decade, several theoretical cross-disciplinary concepts have been developed within IE theory. What was initially used only as a metaphor or buzzword came to be studied more carefully and in depth (Adner et al., 2010; Gawer et al., 2014; Gawer, A., 2014). Several attempts to validate a theory of IE have produced significant results that require more attention in terms of both theory and praxis (Parisot et al., 2017a, 2017b; Rong, Ke et al., 2015c).

Within the advances in the field, several theoretical constructs have been identified (Adner, 2017; Faissal Bassis et al., 2018; Gomes et al., 2016; Kœnig, 2012) as fundamental to the understanding of IE phenomena, including the adoption of the logic of the value stream between the actors of the ecosystem as a strategic element adding value to the customer in a scale form incomparably more robust than the value delivered to the customer by only one company (Sacchetti et al., 2016). According to Hwang et al. (2013), IEs are important because their growing adoption points to a profound shift in how society thinks of economic value. Value, in the context of an IE, is centered on customer needs.

Another construct identified in the IE is a perspective that goes beyond the traditional concept of industry and sector towards inter-industrial relations as a source of competitiveness, adopting practices of cross-industrial innovation (Enkel et al., 2010; Hahn, 2015; Hauschild, 2017; Heuer, 2011). In this dynamic, the value stream in an IE establishes non-traditional relationships such as collaboration with competitors, that is, co-opetition (Brandenburger et al., 1998). Since profits and revenues in an IE are the result of the flow of value, the focus is therefore on value in context; in other words, on the capture of value and its generation through orchestrated strategies (Valkokari et al., 2017). Emerging strategies, such as the matchmaker, the magnet and the toolbox, point to a scenario where actors in the IE operate in an orchestrated fashion (Bonchek et al., 2013).

As concerns the scenario of intensive collaboration as part of the IE context, we found companies using platforms to innovate through services in social networks. They capture value through the continuous interactions among platform members (Jacobides, Michael G et al., 2018; Parker et al., 2018a; Parker et al., 2018b; Täuscher et al., 2018; Van Alstyne et al., 2016). User communities leverage value capture in service platform-based interactions (Choudary, 2018). According to Parker et al. (2018b), companies deploying platform business models continue to

surprise and challenge conventional approaches to creating value. Other important elements identified as key to understanding innovation systems are shared or embedded complementarities. According to Gobble (2014), IEs are dynamic, purposive communities with complex, interlocking relationships built on collaboration, trust and the co-creation of value, and specializing in the exploitation of a shared set of complementary technologies or competencies. Through collaboration, capabilities are shared or embedded (Snyder et al., 2003) with other actors in the IE, enhancing not only co-creation but also the capture of value made available in the IE in an orchestrated way.

In terms of value capture, several publications point to open innovation as the background to innovation strategies in an ecosystem (Appleyard et al., 2017; Chesbrough et al., 2014; Curley et al., 2013; Pilinkiene et al., 2014; Wulf et al., 2016). Open Business Models like crowdsourcing (Shaughnessy, 2014), long-tail (Osterwalder et al., 2010), open source (Ying et al., 2011), revenue or cost sharing (Tuomo Kinnunen, 2013), peer-to-peer (Amit et al., 2015), orchestration (Ritala et al., 2013) and leverage customer data (Choudary, 2018) are some examples of open business models that are part of open innovation from a strategy perspective. For the purpose of this study, we adopted the open business models concept as a category of business models in which collaboration of a focal firm with its ecosystem is a decisive or novel element in value creation and capture.

According to Chesbrough et al. (2006), “in systemic innovation, companies need new tools for foresight and shaping to manage the business environment.” Also, we found several studies in the literature on open innovation (Bogers et al., 2017; Hidalgo et al., 2008; Igartua-Lopez et al., 2010; Riedl et al., 2011) pointing out the need to create empirical support approaches in the analysis of open strategies. This research thus intends to fill this gap. Table 5.2 summarizes the

aforementioned elements for the assessment of an IE from a value perspective; that is, the "business environment" elements that serve as links to the integration of the IE and roadmapping in our approach.

Table 5.2 : Key dimensions for assessing an IE

Value context	Value capture	Value creation
• Cross-industrial dynamics & Competition • Collaboration & Coopetition • Customers' needs	• Open business models • Emergent strategies • Social Network & Communities • Platforms & Orchestration	• Co-creation & Development • Intensive Interactions • Shared & Embedded capabilities

In terms of praxis, an extensive literature review of existing approaches, tools and methods was developed to help create the architecture of the intended approach. This review included white papers, conference proceedings and informal communications. At the time this article was written, we identified a number of different tools, methods and approaches in the literature for IE identification and assessment, which are shown in Table 5.3. Although our proposition was inspired and nourished by these methods, none of them suits our needs as significant limitations were noted in each respecting their applicability for strategic thinking at the firm level. As can be inferred from the analysis of the Table 5.3, certain methods, such as the value chain ((Tian et al., 2008), (Adner, 2012; Leavy, 2012) and (Urmetzer, Florian 2014; Urmetzer, Florian, 2015; Urmetzer, Florian et al., 2016)) or simply the ecosystem's industrial links ((Basole, R. C., 2014; Basole, Rahul C. et al., 2013; Basole, Rahul C. et al., 2015)), focus on parts of the ecosystems rather than on the whole. Another important limitation is the specialization of the method to specific situations (e.g. (Basole, R. C., 2014; Basole, Rahul C. et al., 2013; Basole, Rahul C. et al., 2015), which is suitable for local or regional systems, while (Rong, Ke et al., 2015a) is aimed at IoT companies). There are also some methods that are not intended for strategy or in which the involvement of corporate

technology strategy is not straightforward ((Adner, 2012; Leavy, 2012), (Basole, R. C., 2014; Basole, Rahul C. et al., 2013; Basole, Rahul C. et al., 2015), (Basole, R. C., 2014; Basole, Rahul C. et al., 2013; Basole, Rahul C. et al., 2015)). The publications on the methods did not present in-depth case studies that applied the field approach ((Tian et al., 2008) and (Talmar et al., 2018)). In addition, certain publications did not identify the limitations of the approaches and failed to point out the improvements to be made following their testing (e.g. (Bahari et al., 2015), (Battistella et al., 2013), and (Urmetzer, Florian 2014; Urmetzer, Florian, 2015; Urmetzer, Florian et al., 2016)).

Finally, in some cases there are limitations respecting the ease of visualizing the analysis results (e.g. (Battistella et al., 2013), (Urmetzer, Florian 2014; Urmetzer, Florian, 2015; Urmetzer, Florian et al., 2016), (Basole, R. C., 2014; Basole, Rahul C. et al., 2013; Basole, Rahul C. et al., 2015), (Bahari et al., 2015), and (Rong, Ke et al., 2015a)). The methods that are closest to that proposed here are (Battistella et al., 2013) and (Kastalli et al., 2014), where the authors have also identified the potential of integration to roadmapping methods. However, even these approaches have significant limitations as concerns the lack of generality of the current model, since visualization of the results is not very intuitive, and the proposition is too exploratory and based on little documental support on how to use the approaches in practice.

Table 5.3 : Inventory of IE tools and approaches

Ref.	IE tools and approaches	Main characteristics	Limitations of the optics of this proposal
(Adner, 2012; Leavy, 2012)	Value Blueprint Mapping	- Visual approach. - Focus is on performing risk analyses for specific product design based on co-development scenarios. - Draws strategic recommendations.	- The focus of the analysis is on the business value chain rather than on the ecosystem as a whole. - Intended for NPD risk assessment. - Not integrated with corporate strategy.

Table 5.3: Inventory of IE tools and approaches

Ref.	IE tools and approaches	Main characteristics	Limitations of the optics of this proposal
(Tian et al., 2008)	BEAM framework	- Comprises IE modeling, simulation and analysis. - Integrates methods from value network modeling, game theory analysis, and multiagent systems - Draws strategic recommendations.	- The focus of the analysis is on the business value chain rather than on the ecosystem as a whole. - Based on agent modeling. - Lacks a strategic focus - The framework requires knowledge in game theory. - The framework is service driven only.
(Battistella et al., 2013)	Methodology of business ecosystem network analysis (MOBENA)	- Evaluates the strength of ties by means of network centralization calculations. - Relies on proprietary data from the company to perform analyses. - The approach is capable of predicting likely future relationships and drawing recommendations. - Integration of tool has been tested with technology roadmapping.	- Roadmapping integration is exploratory and involves the actual participation of a group of collaborating companies. - Data obtained from interviews: might not be suited to small companies that do not have a strong business intelligence system in place.. - Analyses of the IE approach have been tailored for telecom companies: data compliance should be adapted for other segments. - Many details are not available for the complete understanding of how the approach was applied. - Lack of documentation on how to use the tool.
(Urmetzer, Florian 2014; Urmetzer, Florian et al., 2016)	Ecosystem Value Framework	- Use of multiple sources to gather data (internal data, external data and interviews). - Focus on the creation and capture of value within the value chain.	- The focus of the analysis is on the business value chain rather than on the ecosystem as a whole. - It is a diagnosis rather than an assessment tool (it is not clear how recommendations are drawn from the analysis). - Lack of documentation on how to use the approach.

Table 5.3: Inventory of IE tools and approaches

Ref.	IE tools and approaches	Main characteristics	Limitations of the optics of this proposal
(Kastalli et al., 2014)	Cambridge Ecosystem Framework	- Visual approach. - Identifies and clusters players by their function in the ecosystem. - Combines internal data with external public data on the web.	- Framework is more suitable for local ecosystem mapping (e.g. cities). - The method only takes a photograph of the map (identification only, not for assessment). - Not integrated with corporate strategy.
(Basole, R. C., 2014; Basole, Rahul C. et al., 2013; Basole, Rahul C. et al., 2015)	Visual Business Ecosystem Intelligence	- Data-driven analyses that are not biased or limited by the data provided by the company, as it also searches for publicly available information on the web (data mining).	- Not integrated with corporate strategy. - Cases presented in papers are mostly focused on industrial links (it is not clear whether the broad concept of ecosystems is being adopted).
(Rong, Ke et al., 2015a)	6C framework	- Database for analyses are built from the company system of IoT (Internet of Things), which must integrate its clients or suppliers. - Data mining techniques are used to make sense of the data collected in real time.	- Made only for IoT companies - Not a visual approach (data structure is quite complex and intended for automated real-time decision-making rather than communication of the ecosystem).
(Bahari et al., 2015)	Ecosystem Business Model (EBM)	- Focuses on multi-actor business models. - Composed through monetary flow analysis, contributor/beneficiary analysis and gains of each actor.	- Financial centric only. - The methodology of approach construction is unclear. - The constructs of the approach were not identified. - Lack of documentation on how to use the approach. - Open strategies are not considered in the analyses.

Table 5.3: Inventory of IE tools and approaches

Ref.	IE tools and approaches	Main characteristics	Limitations of the optics of this proposal
(Talmar et al., 2018)	Ecosystem Pie Model tool	- Visual approach. - Focus on risk management. - Assesses the value ecosystem. - Bimodal analysis from both actor and ecosystem perspective. - Well documented.	- Absence of a prior diagnosis of the current ecosystem. - Only one case study was found. - Open strategies are not considered in the analyses. - The understanding of visual representation is restricted without interpretative support.

Comparison of the methods reveals that the literature analysis on assessing IE lacks focus on a vision of IE as a whole. Also, although several methods use IE terms, they continue to apply the traditional value chain mindset, sometimes with a slight, but less than thorough, slant towards an ecosystem. The value analysis of an ecosystem focusing on innovation strategies was found in only two methods: MOBENA (Battistella et al., 2013) and the Cambridge Ecosystem Framework (Kastalli et al., 2014). The presentation of case studies is another point to be further explored as we believe that more empirical studies are required. The absence of the approach usage references shows the conceptual nature of the methods, placing practical use in the background or even ignoring use in praxis way. Most quantitative approaches ignore the collaborative aspects of strategy building. Strategies based on open business models were not noted in any approach.

In short, the limitations found in the existing approaches and methods confirm the need for a new general-use approach that could be integrated into the strategic planning roadmap at the firm level.

5.5 Preliminary empirical case studies

As explained in the methodology section, the second phase in our research design involves empirical studies aimed at increasing our understanding of the problem of the research design. It is particularly important to identify the critical success factors for the design approach by undertaking preliminary field work to determine the constraints and requirements that are not currently clear from the literature (Blessing et al., 2009).

Considering the need for the practical application of the proposed approach, we identified the need to apply roadmapping to collect empirical evidence, observing situations and contexts that are difficult to identify through a literary review. The context chosen was as follows: roadmapping potential points of integration with the "IE Approach" tool, the value of insights and shared opinions during the workshops, the stakeholder perspectives, and the value analysis and its visual time-based logic ("as-is" and "to-be"). We decided to strengthen knowledge-sharing activities in the discussions and dynamics of the workshops since, on several occasions during the literature review, we noted the importance of knowledge as one of the key benefits of roadmapping (Cetindamar et al., 2009; Phaal et al., 2004; Phaal et al., 2007; Phaal et al., 2010; Phaal et al., 2009; Shehabuddeen et al., 2006) and since roadmapping is typically characterized by a strong consensus-building process, based on a shared vision and agreed actions (Londo et al., 2013).

5.5.1 Case study 1 – Application of a roadmapping tool

The first field study was performed in a Canadian startup in the IoT industry that bridges the gap between electronic devices and their surroundings. Its business models are based on open source software (platform-based and community supported), modular hardware (tech products) and extensive expertise (consulting) that the company can also exploit in more complex business models. In examining this company, we used the T-Plan process (Phaal, Robert et al., 2001) to

develop its strategy through roadmapping. The T-plan process, a “fast start” approach for implementing roadmapping in a firm (Phaal, Robert et al., 2001) through four workshops, can be implemented in two days. It provides a way to evaluate the potential benefits of technology roadmapping through the rapid application of the method to an area of business interest. It also enables the design of a tailored roadmap that meets specific company needs (Phaal, Robert et al., 2001). Given the small size of the company, the T-Plan process was adapted to its context. During the workshops, we followed the T-Plan guide (Phaal, Robert et al., 2001) as closely as possible. As indicated in this guide (Phaal, Robert et al., 2001), the associated tools for constructing a roadmap were established in the workshops. They were: (1) the company's SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis, (2) the categorized and prioritized market and business growth factors, (3) the categorized and prioritized product features and functionality, and (4) the categorized and prioritized alternative and technologies. A first version of the roadmap was built from these elements, which was to the company’s satisfaction. A report was drafted on the roadmapping analysis describing the roadmapping process, presenting the results of the roadmapping workshops and drawing some strategical recommendations for the company to reap the most benefit from the roadmapping exercise and to improve and periodically update it, as is prescribed in the T-plan approach. This report was subsequently discussed with the company founder and CEO.

Key findings – Several practical lessons were learned from the roadmapping experience.

First, the workshops served as an alternative framework for communication between the company members on its vision and strategy. The workshop-based format enabled the exchange of ideas, which proved to be a gain for the startup. In fact, during the post-mortem interview, the CEO indicated that the exercise had made it possible for him to finally put on paper and communicate

his vision for the company. Similarly, another co-founder, who is more involved in the firm's commercial activities, reported in his post-workshop survey that the roadmapping exercise had helped him finally understand what was in his partner's mind. The lesson learned here is how a workshop can promote interaction and discussion among people from different contexts with distinct perspectives and viewpoints within the company. According to the participants' comments, the T-Plan approach improved the company's self-knowledge. Another aspect identified as fundamental to developing the roadmap was the discussion among the participants during the workshops. We noted that the quality of the workshop results depended on the level of participation and the sharing of information among participants.

At the same time, great care is required in analyzing the data collected since the roadmapping approach is based on qualitative evidence (Phaal, R. et al., 2015; Shehabuddeen et al., 2006). We actually see this as a weakness in the roadmapping process because it will produce results irrespective of whether good qualitative empirical evidence or subjective and anecdotal information is used. In the workshop discussions, insights arise, decisions are made, divergences are noted, and opinions are clearly expressed. However, the success of a roadmap is tied to the quality of knowledge captured (Brown et al., 2001). In the case study we performed, we noticed that all participants relied on the opinion of the CEO and founder as the ultimate reference in terms of trends in technology and competition, which is obviously risky. Accordingly, the integration of quantitative analyses to roadmapping (e.g. (Jeong et al., 2015)) is a current trend in roadmapping literature.

Lastly, from the perspective of the roadmapping process itself, the essential inputs that were identified deal with data, information and knowledge related to the business environment, the market sector and technology forecasting. These factors require a systematic and coordinated

knowledge of the company's internal reality yet, at the same time, they are subject to ongoing changes and even influence the continuity of the firm's business. In fact, this is yet another flaw in the roadmapping process, which does not consider an analysis of the innovation articulating a strategy or platform for co-creation and collaboration where multiple actors carry out the same strategy but with a different value stream. Essentially, in its original form, roadmapping is firm-oriented rather than network-oriented. In an open innovation context, in which new products emerge from collaboration rather than from standalone initiatives, as is the case in the IoT industry, a roadmapping approach that does not systematically take into account the network effect is likely to be incomplete or ineffective. In our field study, we encountered several instances where the discussion revolved around collaboration and ecosystem issues. Once again, in lack of a better source, it was the CEO's perspective that often prevailed, despite our efforts as mediators to attenuate his influence over the group.

5.5.2 Case studies 2 and 3 – Application of IE assessment tools

As previously mentioned, among the frameworks, methods and approaches analyzed in the comparative table 5-3 of the literature review, only two corresponded to the context of this research: MOBENA (Battistella et al., 2013) and Cambridge Ecosystem Framework (Kastalli et al., 2014). Both were considered more relevant due to the analysis of value flow and strategy design method. Two field case studies were conducted to test and learn from these tools in order to gather knowledge for our own approach proposition.

In the first of these cases, we used the Cambridge Ecosystem Framework (Kastalli et al., 2014), which is intended to identify, classify and analyze the actors of an ecosystem and their respective roles, and includes a mapping of innovation opportunities. The framework was applied in the

context of a Canadian SME that provides IoT analytics and artificial intelligence solutions to connected product manufacturers.

Our field work in this case study consisted in a preliminary data collection, followed by an interview with the founder of the company and, lastly, a validation of all integrated information in the form of an executive report submitted to the company. Parallel to the IE assessment service provided, the research team performed an analysis with field notes aimed at critically evaluating the application of the framework and identifying IE assessment “best practices” for firm-level strategic thinking purposes.

Our main observations identified the key characteristics of the framework, showing that it enables the assessment of: (1) the roles of each actor, facilitating the company's understanding of their relevance (2) possible complementarities with other actors, (3) the next steps towards a future strategy of leadership in the ecosystem, (4) which future strategies are most attractive in terms of risks and opportunities vis-a-vis the role of current actors, (5) the capabilities that can be embedded in the company's business models through collaboration with other ecosystem actors, and finally, (6) the flow of value among the players in the current ecosystem. Also, the actor mapping model is a strong feature of the framework.

Although we found only one publication on the approach itself, it is well documented as to the application of the approach process as it cites a step-by-step approach based on three case studies. It was therefore easy to apply without third-party support and demonstrated the strong usability of the generic approach. In this case study, we found the need to develop a prior list of actors (taxonomy) involved or potentially involved in the company’s ecosystem as support for the development of the actor map.

The second case study used the MOBENA method (Battistella et al., 2013) in the context of a Canadian SME smart-home product provider that provides AI-enabled IoT solutions for homeowners.

The approach proposed by MOBENA aims at analyzing, modeling and predicting the IE as network structures interacting one with the other by using network analysis. According to Battistella et al. (2013), MOBENA is designed to support the identification and understanding of the ecosystems by providing the criteria to define its structure and analyze and evaluate the relevant behaviour.

The approach is based on four steps of analysis: (1) the ecosystem perimeter, elements and relationships; (2) ecosystem model representation and data validation; (3) ecosystem analysis; and (4) ecosystem evolution. All these steps were performed in interaction with a focus point in the company, a senior manager and one of the SME co-founders. Two interviews were conducted in all.

Although the approach is well structured, its application requires knowledge of network analysis and the articulation of the information is quite complex. Since documentation of the articles and publications on the approach were not sufficient to replicate the method, the research team had to fill in several gaps that were unclear in the publications available. In addition, customizing the method for a small company was not that simple since it was developed for a telecom giant. Finally, although the output from the tool was a very complex and sophisticated network-shaped chart, drawing strategic recommendations for the company from it was not necessarily self-evident. Nonetheless, the discussions that emerged during the data collection phase were rich and very useful for the company, as its focus point confided to us. They helped the firm review the importance of certain key partners and identify some missing links in the ecosystem.

In this case study, we identified the need to develop trigger questions to guide us through the interviews and workshops and develop a structure for data collection.

The idea of developing a glossary of terms was also considered since the terms of the analysis of innovation ecosystems were new to those involved in applying the approach.

The findings in these two cases clearly show that there is some potential for applying these tools to strategic thinking, but that the complexity of ecosystems and the steps to map them are accompanied by the risk of losing focus on the essential elements and inundating the participants with non-relevant information.

5.6 Proposing an integrated approach between IE assessment and roadmapping

This prescriptive phase of the research goes a step further by recommending solutions and new ideas to improve any deficiency found. In addition, it provides the assumptions that determine how to achieve the desired result in a particular situation (Kuechler et al., 2008; Sordi et al., 2015).

This prescriptive proposition is based on the principle that analysis of the "business environment" enables integration between the roadmapping toolkit and the IE assessment as a common element. In fact, the roadmapping architecture already contemplates it as a unit of analysis, as can be seen in Figure 5.2.

In our context, the business environment boundaries go beyond the classic concepts of niches, markets, sectors and industries because we adopt a new and broader perspective, the so-called innovation ecosystem, which integrates not only all the previous elements, but also the informal and indirect cross-industry relations, which in turn create and capture value for the business in a networked configuration. Moreover, in this research context, assessment means identifying and analyzing the strategic landscape at the firm level, which requires a customized approach.

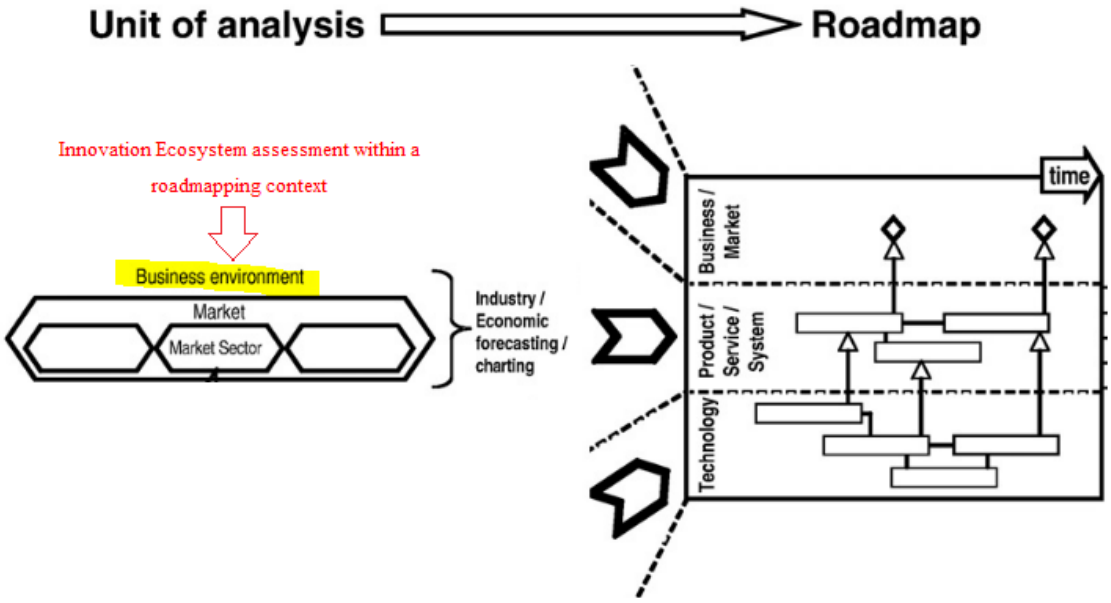


Figure 5.2 : Innovation Ecosystem as input

Adapted from Phaal, Robert et al., 2009

The "customized" approach focuses on the principles of context, process and architecture (Phaal et al., 2007). Thus, the first step in customization is defining our "context" as IE assessment through the stream of value. The second step is to align the proposed IE approach with the practices and principles of roadmapping in terms of praxis defining the "process of applying" the IE assessment approach. The third and last step is to determine which key dimensions (domains of knowledge) found in the IE literature review could be integrated into the roadmapping architecture.

5.6.1 Customization context and assumptions

As concerns the first step, our key dimensions have previously been identified in Table 5.4. Thus, we define our context as IE assessment through the stream of value (context, creation and

capture) through the interactions between the actors within an IE. From these dimensions, the following assumptions were established to define the context of the IE integrative approach we propose.

First, the objective of this IE approach is to provide foresight information – context and focus – and examine previous decisions as support for a strategic roadmapping. Second, the IE approach should provide a basis for identifying patterns and issues for understanding emergent strategies, open business models, ecosystem actors and their interactions as an input to a strategic roadmapping in its value form. In practical terms, this is translated through a workshop dynamic moderated through triggered questions. These questions are driven by key issues, already identified in the literature review, which may essentially be summed up as follows: (1) relevant actors within the current IE, (2) current business models, (3) types of interactions between the actors and (4) strategies adopted in these interactions in terms of open business models.

Lastly, the design and architecture of this approach are based on certain principles of roadmap customization as indicated in the literature (Phaal et al., 2003), such as: (1) the context (scope defining the boundaries and the focal issue), (2) the architecture (layer structured as IE view), (3) workshop-based (the participatory activities) and (4) process-oriented (the staged set of activities needed to build the IE content, make decisions, identify and agree).To design our customized approach, we needed to determine which key dimensions (domains of knowledge) found in the IE literature review (Table 5.2) are relevant to IE assessment within the roadmapping architecture, that is, roadmapping layers, which is closely related to how the IE is structured and viewed.

The layers in a roadmap represent key dimensions of the system being considered, enabling stakeholder perspectives to be presented in a structured manner (Phaal, R. et al., 2011) as recommended (Blackwell et al., 2008; Phaal et al., 2006a; Phaal et al., 2003; Phaal et al., 2006b).

The architecture of the roadmap (the set of layers and sub-layers) reflects the 'innovation system' within the firm (Robert Phaal et al., 2005) and, in our case, will reflect the innovation state within the IE according to the findings in the literature review, the case study of the roadmapping, and the application of the approach in the companies. Thus, we adopt the holistic principle of roadmapping that integrates different domains of knowledge – dimensions – in search of a common language around the IE approach (Phaal et al., 2007). The result of this second step can be seen in Figure 5-3.

Through these dimensions all the findings related to the assessment of the current (as-is scenarios) and potential (to-be) strategies found in the assessed IE during the application of the approach's process, will serve as an input to the design of new strategies in the IE context.

5.6.2 The IE approach

The second step for customization aims to align the proposed IE approach with the practices and principles of roadmapping. Through the principles found in the literature review (Phaal et al., 2003), the assumptions, and the lessons learned in our previous roadmapping case study, we designed an approach consisting of preliminary meetings and two interactive workshops.

The preliminary meetings serve to present the benefits of the approach, resolve doubts and agree on a work plan. At this stage, the company must indicate which product, service or segment of customers will be prioritized for assessment of its related IE. It is crucial at this time to identify the company's current business models, its main competitors and its current innovation initiatives. It is also the moment to determine when the workshops will be held, who should participate and how they should be conducted.

Once this work plan has been established, the next step is to conduct the first workshop.

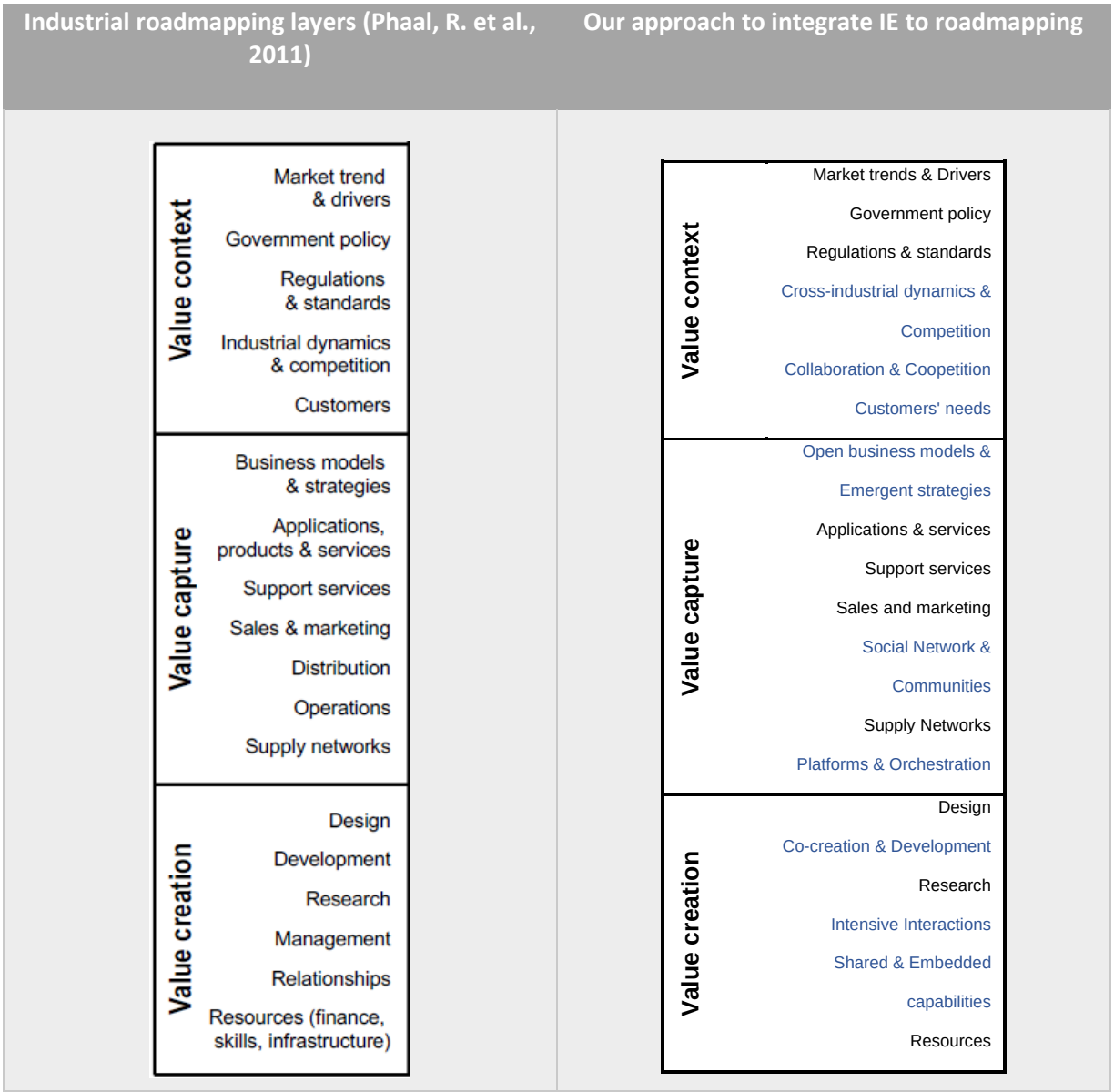


Figure 5.3 : Industrial roadmapping layers and customized roadmapping in an IE context

The first workshop has three main objectives. The first is to identify the relevant players in the current IE in which the company is inserted, and the current strategies that it applies to them (as-is

scenario). The second is to present a reference case to participants in order to enable the appropriation of terms and practices, as well as initiate the modeling of the current ecosystem in which the company is inserted. Finally, the third objective is to identify current competitive contexts and priorities.

Between the first and second workshop, the moderator integrates the data from the preliminary meetings and the lessons learned from the first workshop. The second workshop has five main objectives: (1) to validate the IE developed in the previous workshop; (2) to identify potential actors in the IE for the company's innovation initiatives; (3) to list possible actions (to-be scenarios), players or projects proposed by workshop participants that use the IE to leverage the company's innovation initiatives; (4) to identify the requirements to accomplish them; and lastly (5) to gather all pertinent information for the preparation of the final assessment report, which charts the IE and draws recommendations for strategic purposes.

It is important to note that the outcome of this procedure is not the roadmapping itself, but rather recommendations to leverage the roadmapping through the inclusion of external elements from the company's surrounding innovation ecosystem.

5.7 Tests and discussion of the IE approach proposed

The final step of our research protocol is to perform a number of preliminary tests of our IE approach in order to verify its feasibility and the added value of our proposition. These evaluations can be a useful starting point for an initial identification of the major issues involved in improving the process, in a continuous innovation mindset (Blessing et al., 2009). There are two types of evaluation in the DSR methodology: the application evaluation and the success evaluation (Blessing et al., 2009). While the latter aims at investigating the effect of the intended approach,

the former is intended to determine whether the approach can be used for the task for which it is intended, that is, its usability and applicability (Birkhofer, 2011; Blessing et al., 2009), which is our case.

The application evaluation of our IE approach was carried out via two case studies with two different start-ups not involved in the first descriptive study of this research. One of these focused on technologies for urban mobility and the other on monitoring solutions using drones. The same approach was applied in both companies, following the logics and steps described in the previous section.

In the application of the IE approach in the drone company, the benefit of using a graphical representation as a common language and integrating different domains of knowledge analysis was quickly identified through the participants' comments. The visual representation of the ecosystem enabled the participants to identify the relevant actors within the current IE, their current business models, the types of interactions between actors, and the strategies adopted in these interactions in terms of open business models. This mapping provided a wealth of insights into potential alliances that could be established through the adoption of new and previously unthought-of business strategies, such as the adoption of a community platform of users of services currently provided. The analyses discussed in the second workshop focused on technological trends, competing products, customer needs, cross-industrial innovation and internal innovation initiatives. These central themes of discussion were animated by trigger questions, which proved to be great allies in promoting the exchange of information among people from different areas of the company, as well as in understanding the historical aspects and decision-making that were not familiar to everyone involved in company strategies. At the end of the second workshop, the marketing representative indicated that the dynamics of the discussions and the techniques used in the analysis of possible

future scenarios provided new insights for the next actions to be taken in marketing and internal communication. The assessment of its IE through “cross-industrial innovation” revealed numerous innovation opportunities in industrial sectors as yet unexplored by the company. The exercise also provided insights into partnerships with actors who were initially considered as competitors (coopetition). From the perspective of applicability, the relevance of the IE approach reached its goal through the validation of those involved because they succeeded in developing insights and knowledge and decisions were leveraged after its application.

In the second case study, the urban mobility company adopted a classic business model of product retailing, mainly using primarily e-commerce platforms, with solutions integrated with multiplatform applications (iOS and Android) for a personalized user experience, and innovation characterized by its unique design and outstanding features. According to the company founder and CEO, the main innovation challenge when the IE exercise was performed was the launch of the next generation of their smart device. The assessment of the company's IE encountered many problems and limitations throughout the approach, including the sole participation of the founder of the company, the time restriction and the rather strong mindset to medium- and long-term analyses. The absence of other participants was shown to be very important since most of the benefits from the workshop dynamics, such as the moments of collective construction, the decisions based on interactions not approved of or implemented in daily activities, were lost. At the end of the second workshop, the evaluation of IE had little usability or relevance because many ecosystem actors were identified only mid-way through the workshop and were not part of the consolidation between the workshops. Although the relevant data for the approach were requested before the two workshops, we observed that the data were being presented in collated form. As concerns “competition,” it was noted that the participant had insufficient information on

competition but was aware of the need to improve this competence. In the discussion of "trends," we identified the total absence of any prospective activity within the company to search for innovations, apart from innovation in design and correlated characteristics. In terms of future actions with other ecosystem actors, only financial support initiatives were prioritized in a strictly traditional context. The exercise in this company was also useful for the research team since it showed the importance of support tools to maintain the focus of the discussion on the IE elements that might be useful for strategic thinking and avoiding discussions that are off-topic or less relevant. In terms of applicability, the company's founder considered the relevance of the IE approach to be evident because something similar had already been attempted, although with limited success.

At the end of the application of the approach in both companies, the assessment of their IE was submitted to them in the form of a report, which presents the IE chart and makes a number of recommendations for strategic thinking over the short- and medium-term. In general terms, the approach requires usability improvements such as the creation of generic triggers that apply to all companies involved regardless of company size. Other generic artifacts were also identified as necessary for the progress of the workshop discussions. Possible artifacts include: a detailed description of the application of the approach in a format that can be easily understood by workshop participants, a questionnaire evaluating the tool after its application, and a template map of the IE. Another possible consideration for improvement is the application of principles of agility in applying the IE approach. Finally, in terms of relevance, both companies were open to a future reuse of the same approach, considering it relevant to the design of their innovation strategies.

5.8 Conclusions

Several factors played a decisive role in the research results. Limitations, challenges and insights were used in a timely manner to achieve the desired benefits. The key benefits perceived by those involved are listed below.

Modeling and assessing the company's IE approach provided many benefits, including: (1) establishment of an understanding of the company's competitive approach in terms of innovation strategies from a new mindset, that is, innovation ecosystems (ecosystem thinking), (2) characterization of value interactions (creation, capture and context) between actors in order to identify new strategies, (3) change in the perception of competition movements from "innovation business models" to "IE," (4) provision of the constructive and innovative exchange of insights between teams favoring improvement in communication and mutual understanding of the company's innovation processes, (5) recommended actions, initiatives, strategies or projects that can benefit the company's innovation process in its ecosystem and finally, (6) through contextual analysis (dialogue strategizing) the identification of barriers, constraints, limitations, mental models and other specific contexts that may limit innovation processes.

Several insights emerged during the research, particularly during the workshop dialogues and dynamics. Discussions in the field of platform thinking sound like the titles of science fiction works. The traditional ideas of niches, markets, value chain and supply chain are still the key reference, leaving aside the innumerable possibilities based on big data where the relevant data create new markets and niches, as in blue ocean strategy. Still, strategy decision makers are not prepared or trained for cross-industry-based innovation, much less for informal relationships with other actors as a source for capturing value in terms of creativity.

The limitation of concepts to assess strategies based on the value perspective found in the literature review was a limiting factor, but at the same time it was appropriate for the articulation of related topics such as ecosystem value, value context, value creation and value capture. The integrated articulation of these concepts provided significant conceptual learning.

A number of challenges arose during the development of the presented approach, among them the understanding of never-before-experienced concepts and perspectives. Accordingly, some support artifacts were created to facilitate the acquisition of specific vocabulary using the same terms throughout the workshop discussions and dynamics.

This study has some limitations. In the roadmapping literature review, the list of references was derived from a single-source database in (Phaal, 2018). Although the advantage of this approach is that the quality and consistency levels of the references are assured, the drawback is that this single source might have recorded only selective references. Also, the limited amount of literature on the development of analytical tools in the field of IE was a real challenge, which limited the possibilities for comparing existing tools. As for the case studies, additional empirical work is required in the case studies where firms are at a mature IE level where elements such as orchestration and metrics in their interactions can be quantified and studied in depth. In this case, the IE of the aerospace industry, the startup ecosystem and the IA ecosystem, among others, are potential sources of countless discoveries to be made in applying the innovation ecosystem approach in an integrated way to roadmapping the actors involved. Finally, a single organization may participate in several linked ecosystems and may have different roles in each. In this research, we were limited to one ecosystem for each company.

Where to go from here

Although it seems obvious, the term “IE” has often been used in a broad and very conceptual manner or as just another buzzword. There is still a long way to go to achieve genuine understanding of it and the application of its analytical tools. Concurrently with the final revision of this article, another publication is being drafted to share the results emerging from the practical applications of the proposed approach in two emerging technology companies located in a complex and highly competitive IE. The first findings show potential elements of evolution in the present IE approach that could become a new foresight toolkit.

CHAPTER 6 ARTICLE 3: "ASSESSING INNOVATION ECOSYSTEMS STRATEGIES AT FIRM LEVEL: PROPOSAL AND TEST OF A TOOLKIT THROUGH CASE STUDIES"

> "The success of company's growth strategy hinges on how well its ecosystem is assessed" – (Adner, 2006).

6.1 Presentation of the article

The multiple case studies performed in the previous article (article 2) and the identification of a predominant heuristic in the decision-making process have enabled the development of an approach integrating the assessment of IE with a technological strategy design tool. This integration was fundamental in the identification of the key variables necessary to assess an ecosystem of innovation and therefore will do part of the constructs that make up the tool proposed in Article 3.

In article 3, a thorough mapping in the literature was made in search of the constructs necessary for the construction of the tool. This paper concludes the research objectives by presenting a tool consisting of its logic, a set of supporting artifacts, visual templates, a taxonomy and a guide for using the tool. The tool was tested in two companies and empirical findings contributed to its refinement. The results found were drawn from a limited number of companies and consequently, this requires further study through further testing.

The article entitled "*Assessing innovation ecosystems strategies at firm level: Proposal and test of a toolkit through case studies*" is co-authored with David Fauteux, Cedric Tawil and Fabiano Armellini. David and Cedric are non-thesis Master students at Polytechnique who conducted the two case studies, after training on the tool. The paper has been submitted for publication in the Journal Technological Forecasting and Social Change on 10 August 2019.

Abstract

Innovation ecosystem is a social system where the platform providers, value suppliers, and consumers interact with one another. They are characterized by high complexity and ambiguity. In this way, the need to understand and rationalize an Innovation Ecosystem (IE) requires logical elements constructed and designed from identified contexts and patterns enhancing company's innovation strategies. Thus, this article proposes a toolkit for innovation ecosystem assessment to support other forecasting tools for strategy analysis and decision-making at firm level. This exploratory and qualitative research, supported by a literature review, presents multiple case studies of technology companies in the fields of the urban mobility and Unmanned Aerial Vehicle (UAV) industries. Within each case study, the IE assessment toolkit was applied for testing purposes. The analysis of the results from these cases allowed verifying that the proposition is timely and pertinent, as new tools are required to assess strategies for exploring complex competitive scenarios determined by fast-changing technologies. These scenarios require a new mindset in the decision-making model, like strategic thinking. This paper contributes to fill a void in the literature at the intersection between technology strategy and open innovation, which lacks works that actually propose a path to design open strategies.

Keywords

Strategy, Innovation Ecosystems, Strategic Thinking, Management tools, open innovation

6.2 Introduction

Traditional views of strategy are inadequate when the strategic challenge is changing. In high velocity and hotly competitive markets, there is simply too much uncertainty for static and highly planned approaches (Eisenhardt, Kathleen M. et al., 1998; Rong, Ke et al., 2013b). Today's business environment requires agility where strategies are emergent, opportunistic and flexible (Laudien et al., 2016; Täuscher et al., 2018; Youngblood, 2000). Adopting a contrasting network approach, organizations focus not on the company or the industry, but the value-creating system itself, within which different economic actors – supplier, partners, allies, and customers – work together to co-produce value (Iansiti, M. et al., 2004a). Where once individual firms battled against each other, today the war is waged between networks of interconnected organizations i.e. Innovation Ecosystems that are defined by Moore (1993) as "…an economic community supported by a foundation of interacting organizations and individuals — the organisms of the business world" (Iansiti, M. et al., 2004a; Iansiti, Marco et al., 2004; Iansiti, M. et al., 2004b; Valkokari, 2015; Valkokari et al., 2017). In this context, innovation ecosystems (IE) can offer unique synergies – organizations and individuals working together – creating more value than they would by acting alone (Steven, D. et al., 2015). In other words, we can affirm that in today's dynamic market environment, no single actor has enough knowledge, capabilities and sufficient human resources to innovate on a globally competitive level (Chandler, J. D. et al., 2010). In the midst of this reality, several studies point to the need for analytical tools in the field of innovation management from the perspective of collective-based innovation (Adams et al., 2006; van der Duin et al., 2014; Zott et al., 2013) at the network level. In response to this need, we intend to fill this void by proposing a toolkit[7] that provides an assessment of a company's surrounding IE to support its strategic design and execution, by emphasizing the adoption of a strategic thinking mindset. The assessment of an IE takes into consideration several elements of network strategies, such as emergent strategies, new business models, platform thinking, cross-industrial relationships, among others. These complex

[7] A toolkit can be defined as the integrated composition of various tools (Kerr et al., 2013) supported by artifacts, templates, quizzes, among other elements. The toolkit presented in this article is called AStra which means: "**A**ssessment of Innovation Ecosystems for new **Stra**tegies" or in a reduced form "AStra™" or "AStra Toolkit".

elements and multi-sided attributes are not contemplated in existing tools that support design strategies such as forecasting tools. The proposed toolkit – AStra (Assessment for Strategy) – was designed to fill this gap, as it integrates these elements and attributes in a value ecosystem perspective to facilitate and integrate the strategic design to the specific IE context. Thus, the purpose of the AStra toolkit is to explore, depict and communicate the interactions between the actors and their business models through emerging strategies with open innovation as the dominant model (Bathelt et al., 2017). One of the original contributions of the article is at the intersection of technology strategy and open innovation, by embedding different roles and strategies, as well as collective strategies (co-evolution, co-creation, co-operation, collaboration, etc.), into a dynamic and competitive cross-industry landscape. This article also contributes to practitioners in the field of innovation management through the proposal of a strategic visual tool for strategy and ecosystem value analysis. To that effect, the remainder of this article is structured according to the AIM(RaD)C Convention (Cargill, 2009) as follows. Section 2 presents the research methodology. It is followed by an analysis of the current literature pertinent to our proposal in Section 3, which presents the logic, principles and constructs that will define our proposition. Section 4 fills the gaps identified in the literature review and builds empirical knowledge by presenting the IE toolkit. Section 5 presents two empirical case studies that were performed to test the toolkit, followed by a critical review analysis in section 6. Section 7 closes the paper with our conclusions.

6.3 Methodology

The methodological design of this article consists of a literature review, tool design and case studies. The literature review aims at finding pertinent previous research on the topic and subject and identifying the theoretical constructs that define the assessment of IE strategies. To that effect, the literature review methodology chosen was qualitative evidence synthesis (Grant et al., 2009), a methodology that is recognized as providing credible and useful material to address practical issues (Bohren et al., 2014; Hannes et al., 2011a) in which the findings from previous studies are integrated in a qualitative form (Hannes et al., 2011b). As it looks for ‘constructs’ that lie in or across multiple studies (Grant et al., 2009; Karimi-Shahanjarini et al., 2019), this method allows one to aggregate explanations of the “how” and the “why”, across multiple contexts and themes are related, in our case, to the innovation phenomena in an IE perspective.

The synthesis took the form of four stages which overlapped to some degree: (1) the coding of the findings of primary studies to identify the rationale i.e. "dominant logic" for assessing innovation ecosystem strategies; (2) the definition of principles according to the research goals; (3) the organization of 'codes' found in literature review as constructs with its related artifacts; (4) the process approach to be used when using Astra toolkit, and finally (5) the case studies used to test AStra toolkit. After the application qualitative evidence synthesis methodology, two preliminary empirical case studies were performed for testing and analysis of the proposed toolkit. One purpose of case study method is to replicate the phenomenon (e.g. ecosystem assessment) in a systematic way (Ghauri, 2004). According to Kitchenham et al. (1995) case studies help scholars and practitioners in evaluating the benefits of methods and tools.

To collect information about the success and failures of the tool application in these cases, two researchers were present in all interactions with the companies, one as the facilitator and the second one as an observer, who took notes with contextual information during the exercise to evaluate the tool. Moreover, post-mortem interviews and a survey were applied to collect the impression and opinion of participants.

The following Figure 6.1 shows the stages of the literature review and case studies as research design steps.

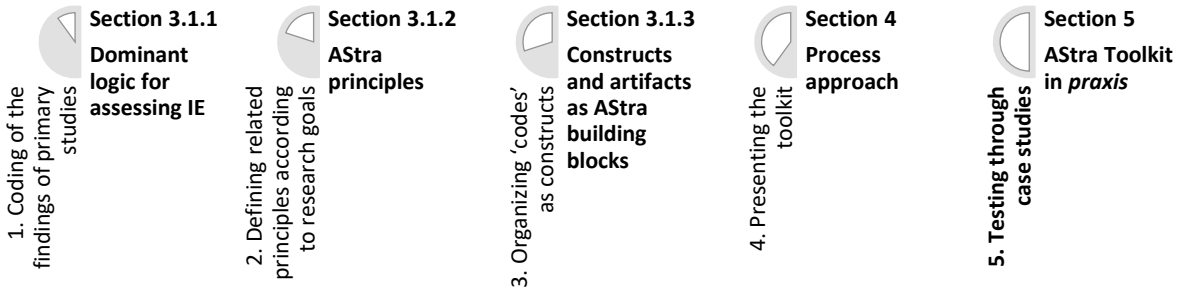


Figure 6.1: Research design

6.4 Literature review

Over the past 20 years, the term "ecosystem" has become pervasive in discussions of strategy (Adner, 2017) and its adoption is present not only in the scientific community (Gawer, A. et al., 2012; Iansiti, M. et al., 2004b; Jacobides, Michael G. et al., 2018; Kapoor et al., 2013) but also in

the community of practitioners (Armstrong et al., 2015; Cruickshank et al., 2011; Daugherty et al., 2016) as well as by policy decision makers (Foster et al., 2013). Systematic research (Parisot et al., 2017a, 2017b; Rong, Ke et al., 2015c) has shown interest in the subject on various IE topics such as: strategy formulation (Iansiti, Marco et al., 2004), digital ecosystems (Nachira et al., 2006), governance framework (Vuori et al., 2004), ecosystem health measurement (Anggraeni et al., 2007), IE Value Creation (Adner, 2012), IE theory for either construct and configuration (Rong, Ke et al., 2015c), proposition of pillars of an IE theory (Parisot et al., 2017a, 2017b), platform strategies in IE (Cusumano, M.A. et al., 2019) among others. However, in the field of strategy there is a gap to be filled, as empirical tools to support the strategy thinking based on an IE assessment are quite rare in the literature. On the one hand, IE is an application of the system thinking (SysT) approach (Faissal Bassis et al., 2018), while, on the other, there is the strategic thinking (StrT) approach. The first is a holistic approach to assess and understand complex phenomena which are influenced by multiple factors and agents (Teixeira de Melo et al., 2019), while the latter consists of a "creative, divergent thought process" aimed at achieving a goal-oriented mindset (Heracleous, 1998, p. 481). Both approaches share converging points, but are different in nature, as one is essentially analytic (SystT) while the other (StrT) related to praxis.

In the last few years, several tools have been developed to help practitioners to integrate this mindset to the corporate culture. Rather than listing them, our goal here is to identify constructs and best practices for strategic management tool design. Tackling precisely the issue of strategic management toolkit design, Kerr et al. (2013) recommend that a complete toolkit should have five attributes: it should be human-centric, flexible, modular, scalable and visual.

Regarding the human-centric attribute, we find a similarity between the two approaches we are trying to integrate here. Among its principles, SysT adopts participatory practices like co-creation and co-design workshops to implement/diffuse design solutions in order to establish a community capable of taking responsibility for its own future (Barton et al., 2004). Successful innovation requires effective communication within and between technical and non-technical communities, in this way workshop sections can enable effective dialogue between these groups, and the way in which information is structured is a key feature that enables this communication (Phaal et al., 2010), since (1) it reflects a system or holistic view that appreciates how the different parts of the organization influence and impinge on each other and (2) it involves thinking in time in two distinct

moments: the AS IS and TO BE states. Following Kerr et al. (2013) recommendations, the visual is also an important attribute, which has been extensively exploited in the last few years in the design of strategic management tools, such as the business model canvas (Osterwalder et al., 2010), the T-plan roadmapping tool (Phaal, Robert et al., 2001) and the value proposition canvas (Osterwalder et al., 2014), to name a few. As for the other three attributes (flexible, modular and scalable), a series of best practices can be associated with them, in the context of the integration with an IE assessment, namely:

- Adoption of a perspective-based approach to competitive environment for value analysis (Dissel et al., 2009);
- The adoption of "trigger questions" to increase the fluidity of the interaction between participants, and also to allow its personalization, according to the specific objectives of the tool (Osterwalder et al., 2010);
- Embedded or shared capabilities involve resources (tangible and non-tangible) that are shared with ecosystem actors and indicate the degree of permeability of the company in its ecosystem which implies its ability to capture value (Grewal et al., 2007);
- The figure of a facilitator or mediator is present in several tools that involve co-creation, and it is a central resource for the success of the exercise. The existence of training kits or reference guides for these people, as found in (Talmar et al., 2018) and (Phaal, Robert et al., 2001)), is thus essential for a complete toolkit.

6.5 Astra toolkit proposal

A conclusion for the previous section is that the integration of the system thinking, and the strategic thinking may be challenging, but it seems to be feasible. The AStra toolkit is an attempt to achieve this integration. AStra is an analytical tool whose primary goal is to help companies in the design of open strategies that are eager to put open innovation theories in practice. AStra is essentially a tool for assessing IE strategies that provides strategic outputs for both *mobilization and ongoing strategic action* or for *traditional strategic planning* tools.

AStra was made for mapping and assessing the IE considering four dimensions, which are seen in Appendix D, as follows: (1) Shared/Embed capabilities; (2) Business models; (3) IE Analysis variables; and (4) Value stream interactions.

IE comprise a complex web of interdependent enterprises and relationships which both create and allocate business value (Steven, D. et al., 2015). Thus, assessing an IE is a complex activity given the number and type of variables – IE Analysis variables – to be considered. At the same time an assessment perspective, among the many possible ones, must be adopted. In the context of this research the assessment perspective is based on the Value Stream within an IE – current and prospective – through the "Value Framework" presented in Table 6-2. This choice was made by the literary review identifying this perspective as a dominant logic in the subject as set out in section 3.1.

The IE assessment is carried out through a sequence of steps that aims to establish the link between the company's open business models and the ecosystem actors identified - supported by a "taxonomy of actors" - and grouped in a visual representation i.e. "Canvas Template". These links are the interactions that establish the value stream. The articulated use of constructs, principles and artifacts identified in this section, is made through a set of activities structured in processes that make up the "AStra Process" approach.

6.5.1 Building blocks

Platts (1993) mentions the importance of formulating processes which link to existing frameworks. The research respects this requirement for the toolkit design, by integrating proved tools from the literature review.

A toolkit can be defined as the integrated composition of various tools (Kerr et al., 2013) supported by artifacts, templates, quizzes, among other elements as constructs. According to the methodology described above, synthesizing qualitative evidence allows us to identify 'constructs' providing useful material to address practice issues in assessing IE strategies. The results of the qualitative research resulted in the constructs classified and described below in Table 6-1. The respective artifacts[8] identify how the theoretical principles and definitions are transcribed in empirical terms in the field of *praxis*.

[8] Artifacts not included in the appendices section of this article may be requested from the authors.

The use and articulation of the constructs as building blocks of AStra toolkit are described in the "AStra Facilitator Guide" artifact and it works through an approach based on key activities that make up the AStra process. To ensure appropriate tool integration, the toolkit follows Kerr et al. (2013) five aforementioned recommendations (human-centric, flexible, modular, scalable and visual). These principles were adopted observing the objectives of this research and are applied both in the construction of the tool and its use through the identified building blocks that are presented in Table 6.1.

Table 6.1: AStra building blocks: constructs, definitions and artifacts

Construct	*Definition*	*Related artifact*
Tool ontology	It is made up of literature review results and related bibliography.	• Bibliography resulting from the literature review as a conceptual support.
Approach (workshop-based)	Participative design workshops to implement/diffuse design solutions and enhancing discussions and reflections that could only be achieved through the dynamics of dialogue.	• Workshops – Set of interactions carried out with the main representatives of the company in two moments: workshops 1 and 2. • Trigger questions – Set of questions designed to facilitate discussions during the workshop, while also generating insights and even supporting the decision-making process (Appendix E).
Process approach *(Appendix A)*	Set of steps and interactive and iterative activities that describe the work dynamics of all those involved in ecosystem assessment. Tools like Kanban-Trello should be used in a collaborative way for facilitating the progress of AStra application	• The AStra process – designed in Kanban-Trello® it is a visual and agile representation of AStra process for dynamic management (Appendix A). • Astra Facilitator Guide – the document of use, context and practices of the AStra toolkit step by step
Value Framework (table 6-2)	A specific AStra tool for "value stream analysis" within an IE modelled on the principles of the AStra toolkit	• AStra Value Framework – This tool develops value stream analysis in an IE considering the value context, value capture and value creation.
IE Analysis Variables *(table 6-2)*	A series of variables chosen as relevant and determinant in the assessment of ecosystem strategies. These variables change according to technological trends and to the intended strategic objectives.	• IE Analysis Variables - Variables represented on a canvas (AStra Canvas template) in distinct groupings showing the value flow and groupings by similarities. In the context of this research, the following variables were chosen: Cross-industrial relationship, collective strategies, open business models and platform strategy.
Open Business Models Inventory *(Appendix B)*	Non-exhaustive inventory of open business models that predominate in open innovation strategies.	• AStra Open Business Models Inventory – This artifact identifies the open business models that require collaboration and value stream among the players in the IE, based on the 55 business-model list from Gassmann et al. (2014)
IE Actors Taxonomy *(Appendix C)*	The "Innovation Ecosystem Actors" (AStra artifact) defines a non-exhaustive list of potential actors participating in an IE.	• Innovation Ecosystem Actors Taxonomy – Structured list of potential actors in an ecosystem. It supports workshop dynamics in the analysis of current and potential IE actors in question.

Table 6.1: AStra building blocks: constructs, definitions and artifacts

Construct	*Definition*	*Related artifact*
Supporting Artifacts (Documentation)	Set of documents designed to provide operational support to IE toolkit users.	• Training templates – Pre-established models of training material and tool presentation. • Canvas Template – A visual template developed for modeling and analyzing an IE by applying the AStra toolkit. It serves as integrated support the discussions and dynamics applied during the two workshops (Appendix D). • Reference case – An example of Canvas Templates to support new Astra toolkit users. It is used during the initial application phase of the tool as an example of how to use it. • AStra Survey – A questionnaire used to assess the satisfaction of AStra users after its application. Artifacts used for continuous improvement of the tool. • Assessment Report – Main result of the application of the AStra tool that presents the IE assessment and recommendations of next steps.
AStra IE Users	Community of professionals and organizations dedicated to improving or using the tool	• AStra Expert – Experienced professionals in innovation management, whether from the academic community or industry segments, dedicated to the evolution of the AStra toolkit. • AStra Team Leader – Professional responsible for the mobilization, communication and implementation of the toolkit in the organization interested in its use. • Facilitator – Professional trained to apply the toolkit in collaboration with the AStra Team Leader and the support of an AStra Expert. • AStra Customer – Organizations interested in using the tool and achieving its benefits.

6.5.2 AStra Process-based approach

The AStra process is a set of steps and interactive and iterative activities that describe the work dynamics of all those involved in ecosystem assessment. It may be implemented by tools like Kanban-Trello in a collaborative way for facilitating the progress of AStra application. The use of the toolkit and its artifacts inventoried in Table 6.1 is made through the following events: (1) interview and previous data collection; (2) two workshops (*as is* and *to be*) and; (3) the value ecosystem analysis i.e. the "IE assessment" report and if necessary, a post-mortem meeting. Figure 6-2 shows the relationship between each event and its related artifact to be used and expected outcomes.

The previous meetings serve to present the benefits of the tool, to solve doubts, to agree a work plan and to guarantee the full respect of the established rules between the parties before the realization of the evaluation. At this moment the company must inform which product, service or segment of customers will be prioritized for assessing the IE. An interview questionnaire can be prepared based on unidentified information during the prior data collection performed prior to the interview. An AStra team leader – from the customer side – should also be defined as an interface between the company and the AStra Facilitator and AStra Experts. Once a "work plan" has been established (agenda of meetings, necessary material resources, transport logistic, list of participants, etc.) and conditions of application of the tool (data to be provided, documentation to be signed and deliveries to be made) between the company and the AStra Team (Expert and Facilitator) the next step is the realization of the first workshop.

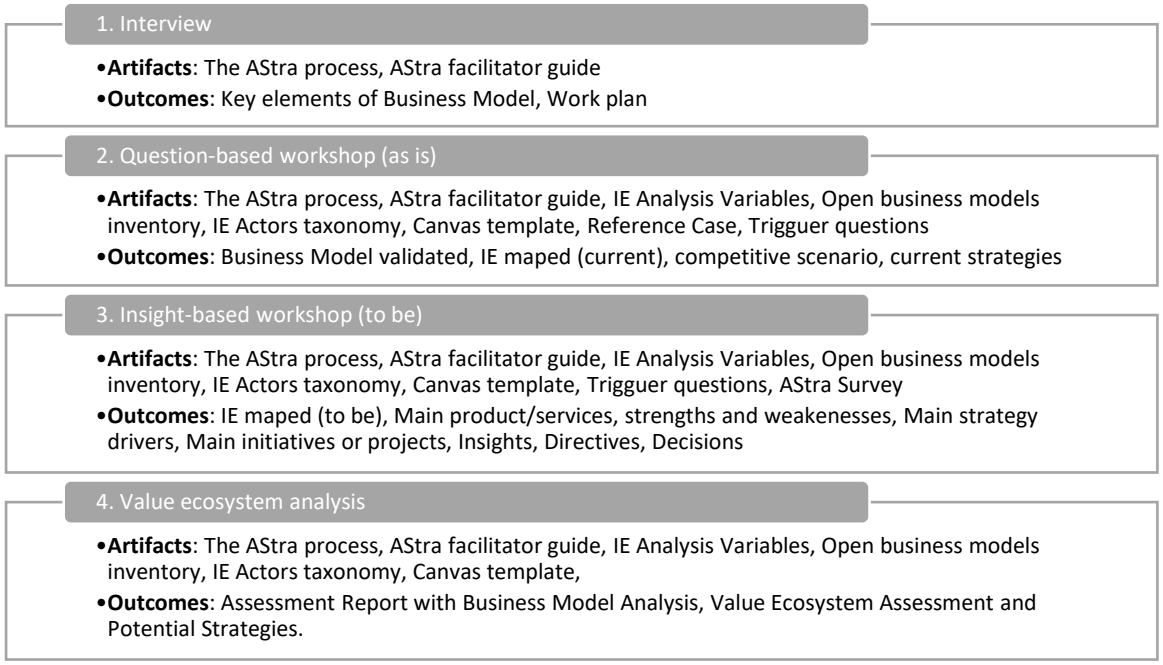


Figure 6.2 : AStra process and its artifacts to be used by events

The workshop 1 is a questions-based activity whose goals are (1) to model the current (AS IS) IE to which the company is inserted, (2) to present the reference case to enable the appropriation of new conceptual terms and, (3) to identify the current competitive scenario and priorities. An initial validation of company's business model is done if the need arises. Next, the mapping of ecosystem elements should be done with the objective of identifying actors, value flows (data,

information, knowledge, transactions, interactions – formal and informal) and current strategies (partnerships, alliances, collaborative innovation projects, patents, research, incubation, venture capital participation, Scaling Up, etc.). In other words, the current reality of the company in its ecosystem and their respective priorities. At the same time a rapid "competitive analysis" is done in order to identify the strengths and weaknesses of the main competitors in relation to the needs of the customers.

In this first workshop the presentation of a Reference Case will help participants to adopt a new mindset through the knowledge of new strategies and terms that are part of the paradigm of innovation ecosystems. At this point that the AStra Facilitator interacts with the participants by asking questions – using the "trigger questions"[9] artifact – about the existence or not of entities (actors) and actions (strategies, value flows, priorities) in the company. Responses will be mapped in parallel by the facilitator who initiates the design of the company's IE and performs annotations of important aspects discussed among the members of the group. The following strategic information must be identified (1) our main products or services; (2) our main strengths and weaknesses; (3) our main strategy drivers like "customer needs" or "market trends" and (4) our main initiatives or projects for innovation. To ensure objectivity during the workshop each item should have a maximum of three items i.e. using relevant information. After the first workshop the integration of all previous collected data, interview and workshop 1 should be made and validated by an AStra Expert.

Therefore workshop 2 is insight based and should begin with the validation of the innovation ecosystem modelled on workshop 1. This activity ensures the review of the most important aspects and at the same time aligns all participants who did not participate in the workshop or who were partially absent. After validation the central point of the discussions should be the "IE Analysis Variables" – an AStra artifact – being addressed one at a time. The revision of the meaning of the IE Analysis variables should be done. In each analyzed variable the actors are identified and modelled on the canvas. The central idea of this workshop is to identify innovation

[9] "Trigger questions" are prompts for connecting innovative ideas. They force you to think outside of the box and generate new solutions around a provocative possibility.

possibilities (value capture or creation) within a broader vision contemplated by its IE. Therefore workshop 2 is insightful based. Thus, the main objectives of workshop 2 are (1) validate IE identified in workshop 1; (2) identify actors of the IE that potentiate possibilities of innovation through the “IE Analysis Variables”; (3) list the possible actions, initiatives or projects proposed by the participants in order to innovate the process of innovation of the company with the vision of IE; (4) identify the requirements to acquire or develop for these actions, initiatives or projects to become a reality and finally; (5) identify all information relevant to the preparation of the assessment report and its recommendations. Once these activities are performed, we may consider terminating the use of the AStra tool. However, some “best practices” are important and some of them discovered during the application of the toolkit are described below.

The initial fill of the Canvas Stage takes place in parallel with the explanation of the Case reference so that the AStra team uses the case as a moment of acquisition of new terms and knowledge (comparative reflection) through reflections based on realities and thus can provide answers framed the reality of the workshop discussion.

In workshop 1 the canvas serves exclusively to identify actors already within the ecosystem of which the company belongs in relation to the four key variables. The “IE analysis variables” are the essential issues that drive the questions to be developed according to the context of each company in the use of the Astra toolkit. The grouping of actors is given by the type of variable used, in this way the analyzes of value flow will be faster and more objective.

The use of the “indication of relevance” made in workshop 1 should be used as a reference element in the discussions contextualizing the most relevant and prior information. It is important to highlight that, for the facilitator to succeed, it is essential that he carry out previous research on the identification of potential actors – by using the IE actor’s taxonomy AStra artifact – in the ecosystem that will make viable the company's innovation initiatives under analysis. Preaching, prospecting techniques should be employed.

The analysis of competition can greatly help the identification of actors and strategies in the innovation ecosystem. IE actors must provide some value that results in some innovation or new competencies or capabilities to innovate. In short, between workshop 1 and workshop 2 the

facilitator should design an IE built in a good level of detail relating the “IE Analysis Variables”. To make this possible a visual artifact was developed to support both workshops.

During the workshop 2, the main function of this stage is, after its validation at the beginning of workshop 2, to develop the identification of actors and respective relationships with the possibility of innovation always observing the relevant indicators developed in workshop 1.

6.5.3 Assessing the IE strategies through the AStra Value Framework

Assessment in the field of management of innovation is the systematic basis for making inferences about something, in our context, we intend to assess the interactions, formal or not formal relationships between the actors within an IE. According Lappi et al. (2015) actors and their relationships are core elements of the innovation ecosystem concept. The dominant logic found - i.e. “value” - in our literary review (section 3.1) defines our contextual scenario and we identified that along with a cohort of related ideas - business models, platforms, coopetition, multi-sided markets, networks, technology systems, supply chains, value networks - the notion of ecosystems has raised awareness and focused attention on new models of value creation and value capture (Adner, 2017).

To systematize the assessment of an IE through its value flow in a structured way, we developed a conceptual support analytical framework aiming to relate the value analysis with the most relevant themes – IE variables – and their respective subthemes found in the literature (Boschma, 2005; Täuscher et al., 2018). The Value framework has three possibilities of value analysis (1) Value context; (2) Value capture and (3) Value creation. Value context is the key driver for a strategic IE’s development which also encompasses barriers and missions (Rong, K. et al., 2010). Ritala et al. (2013, p. 5) defined value creation as “the collaborative processes and activities of creating value for customers and other stakeholders” while value capture “refers to the individual firm-level actualized profit-taking; that is, how firms eventually pursue to reach their own competitive advantages and to reap related profit”. The use of this framework has a chart as both a support tool and a result, which allows to visually present the most relevant aspects discussed during the workshops. According Blackwell et al. (2008) the visualization of the strategy through graphic elements allows greater agility, power of synthesis and construction of new information. Also, Savioz et al. (2002) point out that the visual form makes the toolkits comprehensible and

ready-to-use. The canvas was based on the primordial studies of (Moore, 1993, 1996). Divided into three concentric ellipses (Appendix D), the first represents the company itself and its shared or embed capabilities, the intermediary ellipse represents the business models adopted as ecosystem strategies that require the flow of value with another actor and promote some kind of innovation. The largest ellipse contains the actors identified and grouped according to the "IE variables" chosen as most relevant to the company's strategic context.

Table 6.2 : AStra Value Framework and related IE Analysis Variables/subthemes

	IE Variables – Key themes for Value Analysis	Proposed subthemes to be analyzed
Value context	• Competition • Collaboration • Coopetition • Cross-industrial dynamics • Customers' needs	• Key value proposition: Price/cost/efficiency, Emotional value, Social value • Transaction content & type (combined): Physical products, Digital products, Online services, Offline services • Marketplace participants: C2C, B2C, B2B, B2B2C, B2G • Industry scope: Vertical integration, Horizontal integration, Cross-industrial • Geographic scope: Local, Regional, Global • Barriers: Technological issues, Legal issues, Strategic issues • Missions: Collective strategies, Shared purpose
Value capture	• Open business models • Emergent strategies • Social Network • Communities • Platforms • Orchestration	• Key revenue stream: Commissions, Subscriptions, Advertising • Pricing mechanism: Fixed pricing, Market pricing, Differentiated pricing • Price discrimination: Feature based, Geography based Quantity based, Niche based, Pattern-data based, • Revenue source: Seller Buyer, Hybrid, Third party, None (Free) • Technology based: App-economy, IA based, Deep-learning based, IoT based
Value creation	• Co-creation • Intensive Interactions • Shared & Embedded capabilities	• Customer's collaborative practices: Reading experience, Story experience, Book suggestions, Book recommendations, Community, Application usage experience • Interactions: formal, non-formal • Shared & Embed capabilities (forms of proximity): Cognitive, Organizational, Social, Institutional, Geographical

The Value framework presented in Table 6.2, ideally, should be used from the outset of the AStra tool and is Facilitator's exclusive artifact that should have the domain of knowledge of the most relevant topics in innovation management under an IE perspective. The value framework is an artifact supporting the entire Astra process. As data and information becomes more consistent, new versions of value analyzes gradually emerge. Once the context of the company's innovation needs is identified, the most relevant "IE variables" should be elected. Subthemes are nothing more than an inventory of important subjects that must be discussed in order to seek objective and practical answers during the workshops generating relevant information for assessing IE.

6.6 Multiple case studies – Producing an IE Assessment by testing the AStra toolkit

As explained in the methodology section, the second phase in our research design involves empirical studies aimed at increasing our understanding through tool testing. It is essential to identify the critical success factors for the design approach by undertaking preliminary field work to determine the constraints and requirements that are not currently clear from the literature (Blessing et al., 2009).

Considering the need for the practical application of the AStra toolkit, we identified the need to test the toolkit to collect empirical evidence, observing situations and contexts that are difficult to identify through a literary review. Each case study was structured in four parts and thus conforms to the final assessment report which is based on the AStra "Assessment report" artifact. The four parts are composed by a (1) context of general and historical presentation of the company, the second part by (2) an analysis of the main characteristics of the business model of the company, the third part by (3) an assessment of their interactions – an outcome of "Value Framework" artifact – in the context of the IE and lastly (4) a proposition of strategic possibilities resulting from the assessment made.

6.6.1 Case study 1 - Velo

The first field study was performed in a North American startup, presented here by the fictional name Velo. Focused on the smart urban mobility industry, the company exploits a device for guiding bike riders. Following the success of the company's first product, its founders have

different projects in mind for the next few years. The first one is an upgraded version of their device with enhanced features. Another idea is a built-in add-on installed on electric bikes to offer added features for monthly paying subscribers.

During the preparatory interview, before the first workshop, the company's focal point requested to focus the use of the AStra toolkit in this latter niche opportunity, that is, the customization of their device for electric bicycles. However, since we have learned during the exercise that it is quite difficult to separate product initiatives in start-ups, the case study is concentrated in Velo's global goal and regards its IE in a broader way concentrating on smart urban mobility rather than only on the electric bicycles niche market. Part of the company's growth plan is to have some new products released in the span of 2-3 years. With good technology, progressive urban policy and smart mobility Velo strives to build world class, elegant, and user-friendly products, building the operating system for the future of mobility.

The company was interested in participating in the exercise so to discover any collaboration or business opportunities and innovation hidden inside their ecosystem. The first meeting was a phone call with the CEO to gather general information related to the company. After briefly presenting the project, its benefits and the expected deliverables, the company's innovation need was clearly identified as well as the services and products that should be assessed by the AStra tool, in the context of their innovation ecosystem. After validating the information about the company that the facilitator found (business models, products, services and customers), we have discussed the timeline and schedule for the two workshops.

The workshops were conducted with the company's CEO. The first workshop occurred in the company offices for a total duration time of 45 minutes (less than required to go through all points in the workshop checklist). Besides, it is important to note that the meeting happened on the lounge area without any visual support material. The main goal of the first workshop is to create the "*as is"* innovation ecosystem model. In order to do so, we first presented the reference case from Nike (Appendix D), allowing the CEO to understand what to expect from the tool. Then, a validation of Velo's current business model was performed, and the ecosystem mapping process started through a discussion to identify actors and current strategies. After identifying the top 3 products, a "competitive analysis" to each one of them was performed to identify the main competitors' strengths and weaknesses with respect to the needs of the customers.

The second workshop occurred a week later. This time, a meeting room was booked, visual supports were available, and a convenient time slot was reserved for the workshop. The meeting started by the presentation of a preliminary version of the ecosystem mapping that resulted from the discussions of the first workshop, which was discussed and validated by participants. This feedback from the first workshop helped the CEO to get back to the innovation ecosystem mindset which then allowed us to present all ecosystem actors the company was interacting with, in order identify which actors were indeed involved in the innovation ecosystem. These findings allowed us to find not only to measure the value that current actors add to the company's current innovation strategy, but also helped in the identification of other actors involved in the ecosystem which the company was not interacting with. At the end of the workshop, multiple possible actions, initiatives or projects were proposed by the participants in order to innovate the process of innovation of the company with the vision of ecosystems of innovation. After the second workshop, the requirements to acquire or develop for these actions were identified for initiatives and projects to become a feasible.

6.6.1.1 Business Model Analysis

Velo technologies are concentrated on the future of urban transportation. The first device had a commercial success that exceeded the company's expectations, with sales around the world through conventional retailing vendors. The company was, at the time of the application of the AStra tool, finalizing the development of the second version of their device and preparing for market launch, using the same business model, with the possibility to enable additional features through subscription, exploring the "freemium" business model.

During the first workshop, some future products in their product development portfolio were discussed. The one that we agreed to focus on a product idea that would require the development of partnerships with electric bicycles manufacturers to embed Velo's solution into their product at cost price, and profit from premium subscriptions for additional features, following a freemium business model. Another product idea was about services related to sharing data collected from users for infrastructure players. The latter is far from seeing daylight, though. Nevertheless, for the company to be prepared to it, it should include technical requirements in current products to allow this upgrade when the time comes.

In terms of competition, multiple players could be considered, from the smartphone to the regular bicycle device allowing the user to know more about his or her speed, the distance traveled and the average speed. Regarding specifically the electric bicycle market niche, it was mentioned during AStra workshops that they have standard screens without any navigation or alarm features, therefore, there is room for exploring user-experience improvements in the sector. Because of recent mergers and acquisitions in the segment, it was not clear to them whether some of their direct competitors would remain as so or whether there would be space for having them as clients or to coopete with them. Another trend that was discussed was the fact that this industry is gradually getting distributed, since car manufacturers have a growing interest in electric bicycles. Some traditional players from the automotive sector have started developing prototypes and a few have developed and starting to commercialize their own electric bicycles.

Customer needs have grown and evolved in the last few years since electric bicycles are relatively new. By probing end users, the needs for an intelligent connected device are driven by the fear of bike theft, better battery metrics, better navigation, personal safety features and better fitness metrics.

6.6.1.2 Value Ecosystem Analysis

With the company goal of advancing smart urban mobility, developing relations and collaborating with ecosystem players is crucial. The dynamic between the company and its clients, manufacturers and partners needs to be bidirectional. Bearing in mind the end goal of enhancing and advancing smart urban mobility, Velo will need to collaborate and work with end users, manufacturers, potential partners and even competitors in order to gather all the data required and make its devices and platforms the dominant model within the commute biking community.

The partnerships developed within the ecosystem would require the use of coopetition and co-evolution that were discussed during the second workshop, as competitors would become partners for very specific elements, so to allow both parties to survive, grow and evolve.

6.6.1.3 Potential Strategies

Some possible roadmaps emerged from the discussions during the application of AStra.

The first insight comes from the observation that customers are not only product buyers. They generate relevant data on urban mobility that could be sold to third parties, public and private ones. Since Velo's devices provide intuitive navigation, they should be used during the whole commute process, allowing Velo to collect data from the whole path. Therefore, collaboration with customers is also feasible and desired, therefore, the idea of providing software development kit to allow them to provide complements to Velo's platforms was also taken into account.

Alternative and "out-of-the-box" ideas also emerged from the discussions using AStra, which involved connections with the audio industry, vehicle sharing platforms and insurance companies, to name a few. For all these possibilities that emerged from the discussions during the application of AStra, they were immediately followed by a discussion about the concrete possible actors that could turn this idea into a feasible alternative. Generally, the players were already charted in the ecosystem. When it was not the case, a short discussion would be enough to identify potential new players for the company ecosystem.

6.6.2 Case study 2 – Robbo Services

The second case study to test AStra was performed in a company that we will call here by the fictive name Robbo. Robbo is a technological North American SME (small or medium enterprise) whose mission is to be a pioneer in charting technologies using Unmanned Aerial Vehicle (UAV). Recently, the company has founded a spinoff ("Robbo Services"), in which the application of the AStra tool was focused, whose goal is to directly address their client's needs and offer turnkey solutions in the form of services that use their UAV solutions but adapted to the reality of the customers and users. The main applications of these technologies are used by their first clients for surveillance, charting and monitoring of large sites. These services are useful for several industry segments, from construction and infrastructure to agrobusiness and mining. The company's strategy is to consolidate its positioning in the segments where its clients belong, but Robbo services have already started to roadmap towards different segments, since they were already in contact with potential clients from two different segments by the time the AStra tool was applied.

The two AStra workshops were conducted with a two-week span between one another. Although the management, marketing and technical teams were involved in the exercise, the first workshop was rather an exchange between Robbo's CEO and the AStra facilitator, with occasional

interventions from other participants. In the second workshop, there was a greater interaction among participants, which included UAV specialists, a UAV remote pilot and the marketing director.

6.6.2.1 Business Model Analysis

During the workshop, the three main sources of revenue for Robbo services were initially identified. The competition for these three services was identified mainly in the form of (a) internal services from within their client companies, (b) land surveying firms or, (c) sporadically, "independent" companies are engaged in providing similar services with a much less professional approach, but very affordable prices.

Next, an analysis of strengths and weaknesses of the competition helped in the identification of opportunities for Robbo services for standing out in the market. From the technical and technology perspectives, the main competitive differential of Robbo Services were then identified, which mostly consisted of understanding how the added-value service provided by the company could overcome the menace from “independent” companies to undermine the market, and also the technological benefits of adopting an UAV-based service in contrast to the well-established and dominant service model provided by land surveying firms. In contrast, a major challenge has also been identified in order to align the value proposition right with Robbo core competencies and benefit from faster integration.

The spinoff being relatively young, the business model is relatively simple. In terms of revenues, they are mainly from direct service sales, largely resulting from word-of-mouth business opportunities from their good services provided in the past, or from their presence at commercial events in the segment in which they are already present. Although customers are rather diversified and widespread for the parent company (Robbo), this is not the reality of Robbo Services, as their customers were almost exclusively from the local segment. To increase the scalability of the business, the company should make use of other business models that explore its differential with respect to competition. With the AStra tool, alternatives that explore the company’s surrounding ecosystem were analyzed.

6.6.2.2 Value Ecosystem Analysis

The added value of Robbo Services is well-known within the company. Technological trends, such as the concept of “digital twins” (Uhlemann et al., 2017), have been supporting, throughout the workshops, the evolution of that added value.. Assuming that Robbo Services technologies should go towards this vision for their services, it became clear during the AStra application exercise that the company should go through a vertical integration process and widen its operation scope being active on more links of the value chain than their present footprint. To that effect, the development of new platforms are likely to be the key to increase its service ability to acquire, communicate and process real-time information over their extended reach on the value chain..

The development of these platforms and communication technologies is network-centric, and to collaborate in this environment would require a significant cultural shift for the company. Both Robbo and Robbo Services internalize most of the critical activities (vertical integration) for the sake of management simplicity and protection of intellectual property. Since all technology is provided by the parent company, its transfer to Robbo Services is formalized as a sale "by the piece" at components’ price with for 100% internal integration. The components we are talking here are "off-the-shelf" components, such as sensors, cameras and microelectromechanical systems (MEMS).

Only one external partner was identified before the start of the workshops, on the side of Robbo Services, a software provider offers a solution for generating 3D renderings. Another important partner identified during the workshops was a giant web hosting company whose services are used for data hosting.

During the first workshop, the IE key variables that stood out from the portrait of the innovation ecosystem were then used as starting points for the discussions on the second workshop, such as collaborative platforms, co-evolution, coopetition and artificial intelligence.

6.6.2.3 Potential Strategies

The analysis of the innovation ecosystem of Robbo Services allowed to put forward various strategies based on the identification of certain key players. The discussions here took an interesting path, as the business model inventory artifact (Appendix B) was used a support during the

discussions. For example, an opportunity for collaboration with the government sphere was identified during the workshops using the “leverage customer data” strategy (Gassmann et al., 2014).

There was also a great discussion about possible coopetition strategies with internal departments of large companies, to act as partners and co-develop solutions and services that would make Robbo Services an unavoidable piece of their client’s operations. Some alternative business models were also discussed working with direct competitors, such as the use of the “ingredient branding” strategy (Gassmann et al., 2014), in which Robbo Services would provide its technological services to traditional land surveying companies, to increase the quality and attractiveness of their services, instead of competing with them. Regarding small independent players, a "fractional ownership" approach (Gassmann et al., 2014) would allow them to reach more players in the innovation ecosystem through an income model for the benefit of low-income companies.

Regarding the platform approach, it takes two forms. On the one hand, although Robbo Services is not responsible for the design of UAV, on-board components have a significant influence on the functionalities and solutions offered to customers. It is therefore to the advantage of the company to work closer with component suppliers (which includes its parent company) to ensure proper prioritization of functionalized new products offered to customers. Once again, the business model inventory was evoked to consolidate this idea, through a “lock-in” strategy, in which customers are locked into a vendor's world of products and services, from which they cannot get away without incurring substantial switching costs, and thus protecting the company from losing customers (Gassmann et al., 2014).

Being a young, growing company, Robbo still relies on its initial expertise and any capacity for major business transformation and business model depends heavily on its human and financial resources available. These resources are currently limited hence the importance of a thorough and careful analysis of the available options and also of identifying ways to leverage the company’s business through the exploitation of the surrounding IE. Anyway, most of the strategies described above were considered to be medium- or even long-term options. In the short term, it seemed to workshop participants that the more realistic strategy for the short-term is "layer player" strategy (Gassmann et al., 2014), in which the company remains a company specialized in specific parts of

the value chain, at first by stabilizing Robbo Services actual strength, then gradually evolving towards more lucrative and strategic value proposition. Building on this transformation, the development of platforms should allow Robbo Services to gradually replace the “layer player” approach to set up a business model where the company would become, through its platforms, an orchestrator in different sectors.

6.7 Findings/results – Critical analysis

The analysis of the deliverables from both case studies, combined with the research notes from the observer and the feedback from the participants (post-mortem survey and interviews), allowed us to verify the performance of the tool with respect to its planned goals. In fact, several were performed, while some others were not. Among the objectives achieved we can highlight the following. (1) Firstly, AStra provided a constructive and innovative exchange of insights between teams favoring improvement in communication and mutual understanding of the company's innovation processes. (2) Besides, through contextual analysis (dialogue strategizing), it managed to identify barriers, constraints, limitations, mental models and other specific contexts that could limit innovation processes. (3) Moreover, it allowed to deliver a visual model to assess a company's innovation ecosystem that is at the same time comprehensive, intuitive and informative, and not too complex as some existing IE mapping tools in the literature. (4) The tool provided pertinent recommendations actions, initiatives, strategies or projects that can benefit the process of innovation of the company in its ecosystem. (5) Finally, in both cases the tool succeeded in the identification of new strategies that the company had not been realized by the company prior to the tool application, and it also provided an overview of their requirements for their implementation.

Among the unreached benefits we can list the following. (1) Firstly, although the exercise opened the horizons of the strategic thinking in both cases, we do not believe to have succeeded in establishing an understanding of the company's maturity in terms of innovation strategies from a new mindset: the ecosystem thinking. (2) Secondly, and aligned with the previous comment, the tool did not promote a change in the perception of competition movements from “innovation business models” to “innovation ecosystem thinking”. Putting differently, our impression is that the tool was an excellent ad-hoc exercise to make participants “think outside the box”, using the well-known jargon, but it did not educate participants to adopt an ecosystem thinking that would

systematically integrate IE in the strategic thinking. To investigate how this education can be effectively made may the subject of future research on the topic. Complex variables such as understanding the level of maturity in innovation and changing perceptions about business models require much more time, effort and specific strategies for aspects related to cultural and training issues. We assume that these unreached benefits underestimated the complexity of these variables.

Other benefits that were not previously planned were also achieved by highlighting the following. (1) Firstly, it provided a professional upgraded way for assessing and designing strategies in a quick and collaborative format. (2) Next, it identified “best practices” and other innovation possibilities in an IE context. (3) In addition, more than one participant stated in the post-mortem survey, the workshop approach has also proved its efficacy in (a) communicating the business vision from the senior management to the operational level and (b) in allowing people in the operational level to contribute for the company’s vision.

Some situations got out of the researchers' control and were exploited as an excellent source of learning, which can be summarized as a set of best practices, as follows: (1) Last-minute information of great scope, changes of opinion and other setbacks may occur and should be considered separately and analyzed after the workshops. (2) Besides, it is strongly recommended that, after training, a simulation be done evaluating the performance and improvement points of the AStra toolkit facilitator. In this simulation, the facilitator should prioritize the modeling and analysis of the potential priority company in the application of the tool so that AStra facilitator can help and solve doubts. (3) Furthermore, participants in the workshop should be directly involved in innovation projects and initiatives or in decision-making roles. In this way, the evaluation questions of the current strategies will be at a high level, guaranteeing consequently a good result in the recommendations and new strategies discovered.

Finally, the field experiment using the tool in a real environment allowed the research team to assess the importance of some of the artifacts that were included in the AStra tool. (1) One of the most important was to identify the need for ‘asking questions’ to participants, in order to conduct the workshops, which justify the effort of elaborating compelling “trigger questions” as part of the tool. (2) The importance of discussions in the workshop format with significative participation has also proved to be more effective in the case studies. Indeed, the workshops performed in the Velo case, where participation was quite limited, were much less productive and elucidative than the

workshops for the Robbo Services case. (3) The visual representation of the ecosystem allowed for a quick assimilation of the opportunities by all participants, who were able to quickly identify partners, suppliers and customers for new business ideas that emerged during the workshop discussions. (4) At last, the tool proved itself to be very flexible and adaptable to the user's need: in the case of Velo, since it was a company looking for new product ideas, the workshops headed naturally to that direction; in the case of Robbo Services, we noticed that the discussions were headed towards possible business models and strategies to find new business opportunities for the technologies that have already been deployed.

6.8 Conclusions

The main goal of this research was the proposition of a business management tool for assessing IE for strategic purposes: the AStra toolkit and its analytical value-based framework. Building on existing knowledge of the domain, AStra describes the concepts, elements, attributes, actors, and relationships of an Innovation Ecosystem. Using that were found in the specialized literature, AStra toolkit represents a synthesis of current best practices in the area and a step forward in the rigour of conceptualization.

Comments on the toolkit captured during the workshops with business practitioners have shown that the AStra toolkit and related artifacts have the potential to be further explored. One of the most relevant aspects perceived was the ability of AStra to create a transparent big picture of a business and to externalize the relationships and dependencies of business elements. This aspect is directly related to a more complex reality as to which elements should be considered in strategy design. Furthermore, AStra toolkit was perceived as a tool to create a commonly understood language to improve communication and understanding of the fundamental questions of a business nested in a complex network of value-based interactions. Obviously, this complexity has been reduced with the support of AStra toolkit, however, the complex nature of the strategy is still reflected in the tool when we articulate the identified constructs.

We were exposed to some limitations in this paper. One evident limitation is the fact that the tool was only tested in two case studies. In a mindset of continuous improvement and collaborative development, the tool artifacts are disclosed in the Appendices, so to encourage other researchers and practitioners to use it and improve it. Some avenues for future research using Astra include: (i)

developing a lean version of the AStra toolkit to suit faster product lifecycles; (ii) understanding the best moment to apply the AStra tool, as well as the possible adaptations to its artifacts depending on the maturity of the company's business model and the size of the company; (iii) testing of the tool in distinct ecosystems such as scientific research ecosystems, business environments, intense technological development, context of public policies among others.

In spite of these limitations, we believe that this proposition makes a decisive step for improving platform-based strategies that stand out today as one of the most prominent branches within the theme of innovation ecosystems.

CHAPTER 7 GENERAL DISCUSSIONS AND SYNTHESIS

Articulated in two parts this chapter begins with the synthesis of the main works developed in the creation of the tool presented throughout the research. The second part is devoted to a reflective analysis of this research.

7.1 Synthesis

The main contributions of this thesis are the proposed tool and its Analytical framework value based. Build on existing knowledge of the domain - grounded in a deep literature review - AStra describes the concepts, elements, attributes, actors, and relationships of an Innovation Ecosystem. Regarding comparable concepts, AStra toolkit represents a synthesis of the overall literature and a step forward in the rigor of conceptualization.

A perspective-based approach to competitive environment analysis was adopted from the value analysis proposed in tools such as TRM toolkit (Dissel et al., 2009). In order for information to be fluidly during the workshops a set of “trigger questions” was developed to guide and maintain the intended objectives during the interviews and at each workshop, this practice was inspired by established tools such as Business Model Canvas (Osterwalder et al., 2010). This set of collected information was designed as a visual map – an IE canvas – in order to facilitate the systematic understanding of the ecosystem by pointing out the most relevant elements: (1) the shared or embedded capabilities that are related to open business models, (2) the open business models adopted by the company in relation to each actor of its ecosystem, (3) the actors grouped into “IE variables” or “key dimensions”, the (4) interactions between these actors and the open business model and finally, (5) the links between actors and open business models identify the value stream in the ecosystem generating business capture or value creation results for the business being analyzed. These elements follow the definitions below.

Embedded or shared capabilities involve resources (tangible and non-tangible) that are shared with ecosystem actors and indicate the degree of permeability of the company in its ecosystem which implies its ability to capture value (Grewal et al., 2007). This logical component of AStra toolkit is an essential element in the analysis of the company's degree of permeability in its ability to adopt

open business models by adopting shared (shared own) or embedded (third-party adopted) capabilities.

The business models used in the tool was based on the work of (Gassmann et al., 2014; Gassmann et al., 2016) but prioritize the use of those that have been classified as open models or based on platform strategies so that they are aligned with the IE logic.

The actors identified on the IE canvas are grouped into variables chosen according to the company's characteristics and the potentials of competitiveness in their respective ecosystem. Some of the examples identified as variables relevant to the IE are: Platform strategies (Brousseau et al., 2007; Chen, 2016; Choudary, 2018; Cusumano, M. A. et al., 2002b; Cusumano, M.A. et al., 2019; Daugherty et al., 2016; Evans David, 2003; Gawer, A. et al., 2002; Gawer, A. et al., 2008; McIntyre et al., 2016; Parker et al., 2018b), Collaboration strategies (Adner et al., 2013; Hellström et al., 2015; Kristensen et al., 2016; Majava et al., 2013; van den Besselaar et al., 2012; Wulf et al., 2016), Cross-industrial relationship (Enkel et al., 2010; Hahn, 2015; Heuer, 2011), Coo-petition (Adner, 2017; Chin et al., 2008; Pellegrin-Boucher et al., 2005).

With the support of trigger questions this identification becomes easier and more agile and this artifact was based on works of Osterwalder et al. (2014). Trigger questions are a set of questions designed to facilitate discussions during the workshop, while also generating insights and even supporting the decision-making process.

Another best practice identified in literature and adopted by AStra toolkit was the development of a tool usage guide such as the existing guides identified in (Talmar et al., 2018) and (Phaal, Robert et al., 2001). Finally, regarding the empirical context, the case studies were performed according to the AStra process previously presented in articles 2 and 3.

7.2 General discussion

In 1931, in New Orleans, Louisiana, mathematician Alfred Korzybski presented a paper on mathematical semantics where he introduced and popularized the idea that *the "map is not the territory"* (Alfred, 1933) in other words, the map of reality is not reality (Parrish et al., 2019). Even the best maps are imperfect. That's because they are reductions of what they represent. If AStra

toolkit were to represent the ecosystem “territory” with perfect fidelity, it would no longer be a reduction and thus would no longer be useful to their users. An IE visual representation can also be a snapshot of a point in time, representing something that no longer exists (Parrish et al., 2019). Even if the canvas of AStra advocates a temporary perspective with AS IS or TO BE states identifying current versus intended reality, organizations are abstract, dynamic beings that are filled with innumerable complex and sometimes uncontrollable variables. This is important to keep in mind as we think through problems or opportunities and make better decisions. Although these reflections have its relevance, this does not exempt the researcher from looking at its results and questioning them with sincerity and transparency. From a constructive perspective and questioning helps in improving the work already done. In terms of the analysis of the results found, during an extensive analysis of previously developed research through literature review, it was possible to identify divergences from different perspectives, for example, in the use of metaphor as an element of understanding of the phenomenon of innovation in ecosystem context (Fréry et al., 2012), the use of the term IE as synonym of BE (Ritala et al., 2017), the misleading or poorly structured use of the terms IE and BE in some publications (Oh et al., 2016), the predominance of isolated publications with little or no continuity in a specific group dedicated to the subject among others. Although all these disagreements and discontinuities have been found, we interpret disagreements in the scientific environment as an element of richness in the discussion and elaboration of reflections that would never be made without the benefit of doubt and disagreement. Even if James Moore's foundational works made no effort to ground his theoretical basis as a scientifically structured framework, his contribution sparked debate on a new way of looking at the process of innovation in an interconnected, more complex, and a closer way to reality from big companies like Google and HP. On the other hand, the theory of innovation ecosystems has not yet been established (Rong, Ke et al., 2015a), and in the results found it was possible to identify a new approach that may update or even supersede it. This new approach is in its seminal moment and has been devoted to the study of platform-based strategies, i.e., Platform Ecosystems (Gawer, A., 2009). Although this new approach takes James More's works as a reference, his analysis variables are deeply based on case studies without compromise with the scientific aspect of understanding the phenomenon itself. Researchers recognize that the number of companies studied is small for generalizations. Companies of similar ecosystems may be studied for comparative purposes and

confirming or opposing hypotheses made during the construction of the proposed tool. Among other limitations, the authenticity of the findings may have been influenced by the researchers' interpretation since prior experience in the domain tends toward the previously known responses. Data collection was also a limiting factor since the interviewees' availability time was limited, thus restricting the possibility of other possible analyzes. In the course of the research, several possible ways, methods and approaches were identified for the creation of an innovation ecosystem assessment tool. Orthodox paths based on a simple literature review were found. Purely quantitative possibilities have been identified. We opted for a multidisciplinary approach that considers the various facets of the phenomenon of innovation in its current complexity characterized by many interactions and rich in diverse actors. The consequence of this choice required the definition of relevant variables to be considered as well as the proposition of a guiding and structuring framework of a toolkit integrating numerous techniques, templates and artifacts into a single toolkit. Due to its conceptual nature, directly associated with the literary found and field studies (workshops), the AStra tool has its originality, but at the same time, it has to pass the sieve of the continuous test in order to consolidate its continuation. Identifying empirical elements such as emerging strategies and the application of new strategies has challenged the boundaries of traditional schools of strategy. The identification of constructs and assessment approaches, the integration of the results found with the entire bibliographical review giving theoretical support were developed in order to answer the main research question: How can companies assess their competitive environment taking into account today’s innovation strategies?

The challenge of answering the main question of this research was achieved in terms of an instrumental apparatus integrated in a toolkit. Although the initial idea was a simpler and more agile tool, the final result was larger and more complex requiring future improvement and deeply reflections to simplify and adapt the toolkit according to the IE focal company under analysis. Still, regarding the response to research in terms of tools, the constructs identified (article 2) through the DSR methodology were transformed into artifacts necessary to assess the competitive environment of strategic innovations imbued in an IE. These artifacts and its use in process form has been explained in a user support guide. Developing this artifact allowed us to realize that the theme, being recent, required the construction of sources of basic knowledge that did not exist in the prescriptive format or for novice users, even if some similar tools already existed. This has shown

how far we are from widespread use of the proposed tool – or similar tools – either due to lack of general knowledge or lack of publications on the subject in terms of theory and *praxis*.

The identification of the constructs (article 2) was fundamental in the identification of the theoretical bases from the perspective of IE, however other constructs were found but were not considered because this research was limited to using bibliographical references that applied the principles and knowledge of the ecosystem theory. Thus, adjacent, contiguous, concurrent, or similar theories to the IE theory were not considered in order to respect the scope, objectives, and method of this research.

In the search for dominant heuristic logic used by decision makers, the references used were recent publications on the subject, however, a reference based on empirical findings could be more accurate pointing to other heuristics besides the two found i.e. “open innovation” and “value”.

In terms of research design and methodology the findings of a literature review (article 1) and related articles, System Thinking (SysT) is the school that underlies the IE and NSI theories and therefore the proposed tool has remained within its evolutionary schools. From the theoretical point of view this research used works by authors of the SysT school in a broad way without being limited to a sub-branch of this school of thought.

In article 2 the toolkit was evaluated according to its usability and applicability but its evaluation in terms of its success was not part of the research by scope and time. This limitation restricted the analysis of the tool results in terms of the results achieved by the company over time.

During the case studies, articles 2 and 3 were written in parallel and some interpolations occurred, generating some difficulty in dividing the results into both articles. The case studies were synthesized to the maximum to focus only on usability and results of its construction. Thus, value analyzes were reduced not only by the focus of usability but also to avoid revealing essential data from the companies involved thus respecting the research ethics code. The richness of the value analysis findings was restricted to the final report delivered to companies.

At the beginning of the research some intentions predicted the following benefits: (1) Establish an understanding of the company's maturity in terms of innovation strategies from a new mindset: the ecosystem thinking and (2) Change in the perception of competition movements from “innovation business models” to “innovation ecosystem thinking”. Complex variables such as understanding

the level of maturity in innovation and changing perceptions about business models require much more time, effort and specific strategies for aspects related to cultural and training issues. We assume that these unreached benefits underestimated the complexity of these variables.

Finally, the field experiment – case studies – testing the tool in a real environment allowed the research team identified many challenges to improve the proposed toolkit. One of the difficulties was to represent in the same visual model the value flows between two actors, be they capture or value creation without losing the identification of which trigger element defined the interactions between the actors, business models, and capacities. We sought to identify a way of simply representing something that was not so simple. Finally, we decided to keep the most relevant information for the discussions and decisions that emerged during the workshop and so the visual result was left in the background to further the tool's real purpose: providing “strategic dialogue” and collaborative strategic thinking.

CHAPTER 8 CONCLUSION AND RECOMMENDATIONS

In this research, we aimed to propose and test an analysis toolkit for IE assessment to support other forecasting tools for strategy analysis and decision-making at the firm level. To that effect, we applied the meta-synthesis literature review seeking to identify the "state of the art" of IE based on the identification and analysis of fundamental and seminal works. Then, using the design science research methodology as logical and prescriptive support, we develop an approach to identify and test the requirements – issues, means, and contexts – needed to propose a tool. Through case studies in four companies, other similar tools were assessed, and the built approach was tested. In parallel, using the qualitative evidence synthesis methodology as a procedural reference, the initial findings of the case studies mentioned brought to light facts that evidenced attributes and contexts in the construction of the proposed tool. Finally, through the integration of the theoretical foundations (article 1) and findings of the developed approach (article 2) we applied the qualitative evidence synthesis methodology to design and test the AStra toolkit in two companies (article 3).

As result we identified the most relevant and extensive literature on the IE theory in order to map its scientific approach, definition, typology, terminology, constructs, scope and logic unit. Also, we identified *praxis* issues like best practices, industry role, boundaries, approaches to analyzing. Complementary we proposed a cross-fertilization between some common elements found benefiting both research communities on IE and SI theories. Systematically we identified gaps in existing IE tools through a literature review and study cases in Canadian hi-tech startups that provide products and or services in the Internet of Things, Smart Home, and Big Data analytics domains. Also, we proposed an approach to integrate IE assessment to the roadmapping toolkit identifying its feasibility. Through case studies, we tested the approach and identified the contextual aspects and attributes necessary for the proposition of a structured tool for the evaluation of an ecosystem. Methodologically, we identified the constructs and means needed to evaluate an ecosystem. The findings were integrated with previous results. Artifacts were developed to support the use of the tool and a value analysis framework was created although it was not intended to be designed.

This research contributed to the systematized deepening of the literature in IE and discussed its limitations. Although it is clear that the phenomenon of innovation strategies through IE - whether

via platforms or not - there is much to be studied on the subject. Publications on the theme increased sevenfold if we look at the strategy journals (Cusumano, M.A. et al., 2019). This shows the interest of the scientific community in the world. This research contributed to the construction of a robust theoretical framework thus facilitating further research on the subject. Although the objectives of the research were achieved, we observed that the intention to develop an agile and user-friendly tool found a paradox concerning "the simple representation of the complex world". This paradox has resulted in a more complex tool than we had in mind. Even aware that every tool has its prescriptions the current tool requires high knowledge in the field of innovation strategies, thus not serving novice users. On the other hand, the tool is based on the workshop model, strongly favored the application of the principles of strategic thinking ensuring a dynamic and collaborative strategic analysis and design.

It is essential to highlight the limitations of this research. First, it is worth recalling that it is a qualitative research in which incurs all limitations from the use of this kind of research method. In general, our findings here add to our current knowledge on the subject, as it proposes a new approach and a new tool, which is tested in a real industrial environment, collecting real information is collected from the field (Yin, Robert K, 2011). However, one cannot generalize the results from the cases, since they are not representative of the whole industrial spectrum. Our testing of the toolkit and its related case studies were concentrated on startup companies and this significantly restricts the analysis of the results achieved if we consider the application of the tool to other companies or sectors. Moreover, the application of the tool was restricted to companies with high intensity of use of technological resources and, therefore, requires more tests in other sizes and types of organizations, be they private, public, academic among others. Another limitation of the tool was its focus on the "thinking" aspect of strategy, setting aside the "formulation" since its purpose is to develop an assessment providing insights, discussions, ideas, and collaboration in favor of strategy innovation. It is also worth highlighting that the AStra tool that was designed and tested here is a first cut version of the tool, which still has much room for improvement.

Opportunities for advancement and improvement are still present, so we propose a future research agenda that may include several topics to be deepened such as: developing a lean version of the tool to suit faster product lifecycles, the search for a descriptive model of the use of the most visual

tool, the research and testing of other variables to be considered in IE analysis, the testing of the tool in distinct ecosystems (sectors, domains, cross-industrial contexts) such as scientific research ecosystems, business environments, intense technological development, context of public policies among others. Special attention should be given to deepening platform-based strategies that stand out today as one of the most prominent branches within the theme of IE.

BIBLIOGRAPHY

Abe, H., Ashiki, T., Suzuki, A., Jinno, F., & Sakuma, H. (2009). Integrating business modeling and roadmapping methods – The Innovation Support Technology (IST) approach. *Technological Forecasting and Social Change, 76*(1), 80-90. Retrieved from http://www.sciencedirect.com/science/article/pii/S0040162508001509

Ackerson, L. G. (2007). *Literature search strategies for interdisciplinary research : a sourcebook for scientists and engineers*. Lanham, Md.: Scarecrow Press.

Adams, R., Bessant, J., & Phelps, R. (2006). Innovation management measurement: A review. *International Journal of Management Reviews, 8*(1), 21-47. doi:10.1111/j.1468-2370.2006.00119.x

Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. *Harvard Business Review, 84*(4), 98.

Adner, R. (2012). *The wide lens : a new strategy for innovation*. New York: Portfolio/Penguin.

Adner, R. (2017). Ecosystem as structure: an actionable construct for strategy. *Journal of Management, 43*(1), 39-58. doi:10.1177/0149206316678451

Adner, R., & Kapoor, R. (2010). Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. *Strategic Management Journal, 31*(3), 306-333. doi:10.1002/smj.821

Adner, R., Oxley, J. E., & Silverman, B. S. (2013). Collaboration and Competition in Business Ecosystems. *Advances in Strategic Management 30* ix-xvii. doi:doi:10.1108/S0742-3322(2013)0000030003

Alfred, K. (1933). A Non-Aristotelian System and its Necessity for Rigour in Mathematics and Physics, in "Science and Sanity". *New York, Institute of General Semantics* 747-761.

Amable, B., & Barré, R., Boyer. (1997). *Les systèmes d'innovation à l'ère de la globalisation*. Paris (France) Economica.

Amit, R., & Zott, C. (2015). Crafting Business Architecture: the Antecedents of Business Model Design. *Strategic Entrepreneurship Journal, 9*(4), 331-350. doi:10.1002/sej.1200

An, Y., Lee, S., & Park, Y. (2008). Development of an integrated product-service roadmap with QFD: A case study on mobile communications. *International Journal of Service Industry Management, 19*(5), 621-638. doi:doi:10.1108/09564230810903497

Anderson, P. (1989). Review of Ecological Models of Organizations. [Ecological Models of Organizations., Glenn R. Carroll]. *Administrative Science Quarterly, 34*(3), 503-507. doi:10.2307/2393166

Andrews, K. R. (1971). *The concept of corporate strategy*. Homewood, Ill.,: Dow Jones-Irwin.

Anggraeni, E., den Hartigh, E., & Zegveld, M. (2007). *Business ecosystem as a perspective for studying the relations between firms and their business networks*. Paper presented at the European Chaos/ Complexity in Organisations Network (ECCON), Delft, Netherlands.

Angyal, A. (1941). A Logic of Systems. In T. C. fund (Ed.), *Foundations for a science of personality* (pp. xii, 398 p.). New York: Oxford university press.

Appleyard, M. M., & Chesbrough, H. W. (2017). The Dynamics of Open Strategy: From Adoption to Reversion. *Long Range Planning, 50*(3), 310-321. Retrieved from http://www.sciencedirect.com/science/article/pii/S002463011630067X

Archibugi, D. (2001). Pavitt's taxonomy sixteen years on: a review article. *Economics of Innovation and New Technology, 10*(5), 415-425.

Armstrong, M., Bruun-Jensen, J., Chew, B., Derosby, D., Eggers, W. D., Engelbrecht, W., . . . Muoio, A. (2015). Business ecosystems come of age *Business Trends series*: Deloitte University Press.

Astley, W. G. (1985). The Two Ecologies: Population and Community Perspectives on Organizational Evolution. *Administrative Science Quarterly, 30*(2), 224-241. doi:10.2307/2393106

Astley, W. G., & Fombrun, C. J. (1983). Collective Strategy: Social Ecology of Organizational Environments. *The Academy of Management Review, 8*(4), 576-587.

Ayrikyan, A., & Zaman, M. H. (2012). *Creating an Innovation Ecosystem: Governance and the Growth of Knowledge Economies* (Report No. ISBN 978-1-936727-07-0). Boston: Boston University.

Bahari, N., Maniak, R., & Fernandez, V. (2015). *Ecosystem Business Model design*. Paper presented at the XXIVe Conférence Internationale de Management Stratégique.

Barton, J., Emery, M., Flood, R. L., Selsky, J. W., & Wolstenholme, E. (2004). A Maturing of Systems Thinking? Evidence from Three Perspectives. *Systemic Practice and Action Research, 17*(1), 3-36. doi:10.1023/B:SPAA.0000013419.99623.f0

Basole, R. C. (2014). Visual Business Ecosystem Intelligence: Lessons from the Field. *Computer Graphics and Applications, IEEE, 34*(5), 26-34. doi:10.1109/MCG.2014.104

Basole, R. C., Clear, T., Hu, M., Mehrotra, H., & Stasko, J. (2013). *Understanding Interfirm Relationships in Business Ecosystems with Interactive Visualization.* Paper presented at the IEEE VGTC doi:DOI

Basole, R. C., Russell, M. G., Huhtamäki, J., Rubens, N., Still, K., & Park, H. (2015). Understanding Business Ecosystem Dynamics. *ACM Transactions on Management Information Systems, 6*(2), 1-32. doi:10.1145/2724730

Bassis, N. F., & Barral, W. (2013). *Dynamics of multinational and transnational organizations in the choice by subsidiaries based structures - A Roadmap View*. Brazil: Barral M.Jorge - Consulting Firm in International Trade and Government Relations.

Bateson, G. (1979). *Mind and nature: A necessary unity.* : Hampton Press.

Bathelt, H., Cohendet, P., Henn, S., & Simon, L. (2017). *The Elgar Companion to Innovation and Knowledge Creation*: Edward Elgar Publishing.

Battistella, C., Colucci, K., De Toni, A. F., & Nonino, F. (2013). Methodology of business ecosystems network analysis: A case study in Telecom Italia Future Centre. *Technological Forecasting and Social Change, 80*(6), 1194-1210. doi:10.1016/j.techfore.2012.11.002

Bayazit, N. (2004). Investigating design: A review of forty years of design research. *Design issues, 20*(1), 16-29.

Beaufre, A. (2012). *Introduction à la stratégie*: Hachette Pluriel Editions.

Bernal, L., Dornberger, U., Torres, O., & Byrnes, T. (2009). Technology Roadmapping Handbook *International SEPT Program*. Leipzig, Germany: Universitat Leipzig.

Bertalanffy, L. v. (1969). *General system theory; foundations, development, applications*. New York,: G. Braziller.

Bicking, M., & Wimmer, M. A. (2011, 4-7 Jan. 2011). *Concept to Integrate Open Collaboration in Technology Roadmapping: Stakeholder Involvement in Strategic E-Government Planning.* Paper presented at the 2011 44th Hawaii International Conference on System Sciences (pp. 1-12).doi:DOI

Birkhofer, H. (2011). *The future of design methodology*. Germany: Springer.

Blackwell, A. F., Phaal, R., Eppler, M., & Crilly, N. (2008). *Strategy Roadmaps: New Forms, New Practices*. Paper presented at the 5th International Conference, Diagrams Berlin, Heidelberg.

Blessing, L. T., & Chakrabarti, A. (2009). *DRM: A Design Reseach Methodology*. London: Springer.

Bogers, M., Zobel, A.-K., Afuah, A., Almirall, E., Brunswicker, S., Dahlander, L., . . . Ter Wal, A. L. J. (2017). The open innovation research landscape: established perspectives and emerging themes across different levels of analysis. *Industry and Innovation, 24*(1), 8-40. doi:10.1080/13662716.2016.1240068

Bohren, M. A., Hunter, E. C., Munthe-Kaas, H. M., Souza, J. P., Vogel, J. P., & Gülmezoglu, A. M. (2014). Facilitators and barriers to facility-based delivery in low- and middle-income countries: a qualitative evidence synthesis. *Reproductive Health, 11*(1), 71. doi:10.1186/1742-4755-11-71

Bonchek, M., & Choudary, S. P. (2013). Three elements of a successful platform strategy. *Harvard Business Review, 92*(1-2).

Boschma, R. (2004). Competitiveness of regions from an evolutionary perspective. *Regional studies, 38*(9), 1001-1014.

Boschma, R. (2005). Proximity and innovation: a critical assessment. *Regional studies, 39*(1), 61-74.

Brandenburger, A., & Nalebuff, B. (1998). *Co-opetition* (1st Currency paperback ed.). New York: Currency Doubleday.

Breschi, S., & Malerba, F. (1997). Sectoral innovation systems: technological regimes, Schumpeterian dynamics, and spatial boundaries. *Systems of innovation: Technologies, institutions and organizations* 130-156.

Brousseau, E., & Penard, T. (2007). The Economics of Digital Business Models: A Framework for Analyzing the Economics of Platforms *Review of Network Economics* (Vol. 6).

Brown, R., & O'Hare, S. (2001). The use of technology roadmapping as an enabler of knowledge management.

Camarinha-Matos, L. M. (2009). Collaborative networked organizations: Status and trends in manufacturing. *Annual Reviews in Control, 33*(2), 199-208. Retrieved from http://www.sciencedirect.com/science/article/pii/S1367578809000558

Camarinha-Matos, L. M., Afsarmanesh, H., Galeano, N., & Molina, A. (2009). Collaborative networked organizations – Concepts and practice in manufacturing enterprises. *Computers & Industrial Engineering, 57*(1), 46-60. Retrieved from http://www.sciencedirect.com/science/article/pii/S036083520800301X

Camarinha-Matos, L. M., Boucher, X., & Afsarmanesh, H. (2010). *Collaborative Networks for a Sustainable World*. 11th IFIPWG 5.5Working Conference on Virtual Enterprises, PRO-VE 2010

St. Etienne, France, October 11-13, 2010 Proceedings: Springer-Verlag Berlin Heidelberg.

Cappelletti, L. (2010). *La recherche-intervention: quels usages en contrôle de gestion?* Paper presented at the Crises et nouvelles problématiques de la Valeur (pp. CD-ROM).doi:DOI

Cargill, O. C. (2009). *Writing Scientific Research Articles - Strategy and Steps* Wiley-Blackwell.

Carlsson, B., & Jacobsson, S. (1994). Technological systems and economic policy: the diffusion of factory automation in Sweden. *Research Policy, 23*(3), 235-248.

Carlsson, B., Jacobsson, S., Holmén, M., & Rickne, A. (2002). Innovation systems: analytical and methodological issues. *Research Policy, 31*(2), 233-245. Retrieved from http://www.sciencedirect.com/science/article/pii/S004873330100138X

Cetindamar, D., Phaal, R., & Probert, D. (2009). Understanding technology management as a dynamic capability: A framework for technology management activities. *Technovation, 29*(4), 237-246. doi:10.1016/j.technovation.2008.10.004

Chandler, A. D. (1962). *Strategy and structure: chapters in the history of the industrial enterpise*. Cambridge,: M.I.T. Press.

Chandler, J. D., & Wieland, H. (2010). Embedded Relationships: Implications for Networks, Innovation, and Ecosystems. *Journal of Business Market Management, 4*(4), 199-215. doi:10.1007/s12087-010-0041-5

Checkland, P. (1995). *Critical Issues in Systems Theory and Practice*.

Chen, H.-H. (2016). *Platform Strategies Perspective on the OTT Messaging Services: A Case Study of WeChat and LINE*.

Chesbrough, H., Kim, S., & Agogino, A. (2014). Chez Panisse: Building an Open Innovation Ecosystem. *California Management Review, 56*(4), 144-171. doi:10.1525/cmr.2014.56.4.144

Chesbrough, H., Vanhaverbeke, W., & West, J. (2006). *Open Innovation: Researching a New Paradigm* (1 ed.). United States: Oxford University Press Inc., New York.

Chin, K. S., Chan, B. L., & Lam, P. K. (2008). Identifying and prioritizing critical success factors for coopetition strategy. *Industrial Management & Data Systems, 108*(4), 437-454. doi:doi:10.1108/02635570810868326

Choudary, S. P. (2018). *Platform Thinking - Design Principles for Platform Business Models*. *Platform Strategy Executive Symposium*. Cambridge - USA: MIT Media Lab.

Constantinos, M., Paul, Y. M., & Mintzberg, H. (2000). Strategic Innovation: Constantinos Markides on Strategy and Management [and Commentary]. *The Academy of Management Executive (1993-2005), 14*(3), 43-45.

Cooke, P., Uranga, M. G., & Etxebarria, G. (1997). Regional innovation systems: Institutional and organisational dimensions. *Research policy, 26*(4), 475-491.

Creswell, J. W. (1999). Mixed-method research: Introduction and application. In *Handbook of educational policy* (pp. 455-472): Elsevier.

Cronin, P., Ryan, F., & Coughlan, M. (2008). Undertaking a literature review: a step-by-step approach. *Br J Nurs, 17*(1), 38-43. doi:10.12968/bjon.2008.17.1.28059

Cruickshank, B., Parakala, K., Udhas, P., Khanapurkar, N., & Parekh, H. (2011). *The Cloud Changing the Business Ecosystem*. KPMG International Cooperative.

Curley, M., Donnellan, B., & Costello, G. J. (2013). Innovation Ecosystems: A Conceptual Framework. In E. Commission (Ed.), *Open Innovation Yearbook 2013* (pp. 18-29). Luxembourg: European Commission.

Cusumano, M. A., & Gawer, A. (2002a). The Elements of Platform Leadership. *MIT Sloan Management Review, 43(3), 51. , 43*(3).

Cusumano, M. A., & Gawer, A. (2002b). The elements of platform leadership. *MIT Sloan Management Review, 43*(3), 51.

Cusumano, M. A., Gawer, A., & Yoffie, D. B. (2019). *The Business of Platforms: Strategy in the Age of Digital Competition, Innovation, and Power*: HarperCollins.

Daidj, N. (2010). *De l'évolution des formes d'organisation en réseau : des clusters aux écosystèmes d'affaires - Une revue de la littérature*. Paper presented at the XIXème Conférence de l'AIMS, Luxembourg.

Daidj, N. (2011). Les écosystèmes d'affaires : une nouvelle forme d'organisation en réseau ? *Management & Avenir, 46*(6), 105. doi:10.3917/mav.046.0105

Daugherty, P., Carrel-Billiard, M., & Biltz, M. J. (2016). *Platform Economy: Technology-driven business model innovation from the outside in*. Accenture Technology R&D.

De la Mothe, J. R., & University of Ottawa (2001). *Knowledge management: the new challenge for firms & organizations*. Ottawa: Faculty of Administration, University of Ottawa - Faculté d'administration, Université d'Ottawa.

Denning, S. (2018). *The Age of Agile: How Smart Companies Are Transforming the Way Work Gets Done*: Amacom.

Dissel, M. C., Phaal, R., Farrukh, C. J., & Probert, D. R. (2009). Value Roadmapping. *Research-Technology Management, 52*(6), 45-53. doi:10.1080/08956308.2009.11657599

Dosi, G. (1988). *Technical change and economic theory*. London ; New York: Pinter Publishers.

Edouard, S., & Gratacap, A. S. (2011). Dictature de l'innovation et prime à la nouveauté dans le champ académique. *Revue d'anthropologie des connaissances, 5*(1), 131-154.

Edquist, C. (2001). *The Systems of Innovation Approach and Innovation Policy: An account of the state of the art.* Paper presented at the DRUID Conference, Aalborg (pp. 12-15).doi:DOI

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *Academy of Management Review, 14*(4), 532-550.

Eisenhardt, K. M., & Brown, S. L. (1998). Competing on the Edge: Strategy as Structured Chaos. *Long Range Planning, 31*(5), 786-789. Retrieved from http://www.sciencedirect.com/science/article/pii/S0024630198000922

El Sawy, O. A., & Pereira, F. (2013a). *Business modelling in the dynamic digital space : an ecosystem approach*. Berlin ; New York: Springer.

El Sawy, O. A., & Pereira, F. (2013b). VISOR: A Unified Framework for Business Modeling in the Evolving Digital Space. In *Business Modelling in the Dynamic Digital Space: An Ecosystem Approach* (pp. 21-35). Berlin, Heidelberg: Springer Berlin Heidelberg.

Enkel, E., & Gassmann, O. (2010). Creative imitation: exploring the case of cross-industry innovation. *R&D Management, 40*(3), 256-270. doi:10.1111/j.1467-9310.2010.00591.x

Eppinger, S. D., & Ulrich, K. T. (1995). Product design and development.

Eppler, M. J. (2006). A comparison between concept maps, mind maps, conceptual diagrams, and visual metaphors as complementary tools for knowledge construction and sharing. *Information Visualization, 5*(3), 202-210. doi:10.1057/palgrave.ivs.9500131

Etzkowitz, H., & Leydesdorff, L. (1995). The Triple Helix--University-industry-government relations: A laboratory for knowledge based economic development. *EASST review, 14*(1), 14-19.

Evans David, S. (2003). Some Empirical Aspects of Multi-sided Platform Industries *Review of Network Economics* (Vol. 2).

Fagerberg, J., Mowery, D. C., & Nelson, R. R. (2004). *The Oxford Handbook of Innovation*: Oxford Handbooks in Business & Management.

Faissal Bassis, N., & Armellini, F. (2018). Systems of innovation and innovation ecosystems: a literature review in search of complementarities. *Journal of Evolutionary Economics, 28*(5), 1053-1080. doi:10.1007/s00191-018-0600-6

Fenwick, D., Daim, T. U., & Gerdsri, N. (2009). Value Driven Technology Road Mapping (VTRM) process integrating decision making and marketing tools: Case of Internet security

technologies. *Technological Forecasting and Social Change*, *76*(8), 1055-1077. Retrieved from http://www.sciencedirect.com/science/article/pii/S0040162509000572

Flanagan, T. R., & Christakis, A. N. (2009). *The Talking Point: Creating an Environment for Exploring Complex Meaning*: Information Age Pub.

Foster, G., Carlos Shimizu, Steve Ciesinski, Antonio Davila, Syed Zahoor Hassan, Ning Jia, . . . Diane Lee. (2013). *Entrepreneurial Ecosystems Around the Globe and Company Growth Dynamics*. World Economic Forum.

Freeman, C. (1987). *Technology, policy, and economic performance : lessons from Japan*. London ; New York: Pinter Publishers.

Freeman, C. (1995). The 'National System of Innovation' in historical perspective. *Cambridge Journal of Economics, 19* 5-24.

Freeman, C. (2002). Continental, national and sub-national innovation systems—complementarity and economic growth. *Research Policy*, *31*(2), 191-211. Retrieved from http://www.sciencedirect.com/science/article/pii/S0048733301001366

Fréry, F., Gratacap, A., & Isckia, T. (2012). Les écosystèmes d'affaires, par-delà la métaphore. *Revue française de gestion, 38*(222), 69-75. doi:10.3166/rfg.222.69-75

Gassmann, O., Frankenberger, K., & Csik, M. (2014). *The business model navigator: 55 models that will revolutionise your business*: Pearson UK.

Gassmann, O., Frankenberger, K., & Sauer, R. (2016). *Exploring the Field of Business Model Innovation - New Theoretical Perspective*: Palgrave Macmillan.

Gawer, & Cusumano, M. (2014). Industry Platforms and Ecosystem Innovation. *Journal of Product Innovation Management, 31*(3), 417-433. doi:10.1111/jpim.12105

Gawer, A. (2009). *Platforms, Markets and Innovation*.

Gawer, A. (2012). Industry Platforms and Ecosystem Innovation.

Gawer, A. (2014). Bridging differing perspectives on technological platforms: Toward an integrative framework. *Research Policy*, *43*(7), 1239-1249. Retrieved from http://www.sciencedirect.com/science/article/pii/S0048733314000456

Gawer, A., & Cusumano, M. (2012). *Industry Platforms and Ecosystem Innovation*. Paper presented at the DRUID 2012.

Gawer, A., & Cusumano, M. A. (2002). *Platform leadership : how Intel, Microsoft, and Cisco drive industry innovation*.

Gawer, A., & Cusumano, M. A. (2008). How Companies Become Platform Leaders. *MIT Sloam Management Review, 49*(2).

Ghauri, P. (2004). Designing and Conducting Case Studies in International Business Research. In R. Piekkari & C. Welch (Eds.), *Handbook of Qualitative Research Methods for International Business* (pp. 109-124). Cheltenham, UK: Edward Elgar Publishing.

Ghazinoory, S., Daneshmand-Mehr, M., & Arasti, M. R. (2014). Developing a model for integrating decisions in technology roadmapping by fuzzy PROMETHEE. *Journal of Intelligent & Fuzzy Systems, 26*(2), 625-645.

Ghemawat, P. (2000). Competition and Business Strategy in Historical Perspective. *HBS Comp. & Strategy*

Giebel, M., Essmann, H., Du Preez, N., & Jochem, R. (2009). Improved innovation through the integration of Quality Gates into the Enterprise and Product Lifecycle Roadmaps. *CIRP Journal of Manufacturing science and Technology, 1*(3), 199-205.

Glaser, B. G. (1978). *Theoretical sensitivity: Advances in the methodology of grounded theory*: Sociology Pr.

Glaser, B. G. (1992). *Basics of grounded theory analysis: Emergence vs forcing*: Sociology press.

Gobble, M. M. (2014). Charting the Innovation Ecosystem. *Research-Technology Management, 57*(4), 55-59. doi:10.5437/08956308X5704005

Gomes, L. A. d. V., Facin, A. L. F., Salerno, M. S., & Ikenami, R. K. (2016). Unpacking the innovation ecosystem construct: Evolution, gaps and trends. *Technological Forecasting and Social Change*. Retrieved from http://www.sciencedirect.com/science/article/pii/S0040162516306576

Graetz, F. (2002). Strategic thinking versus strategic planning: Towards understanding the complementarities. *Management Decision, 40*(5), 456-462. doi:10.1108/00251740210430434

Grant, M. J., & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Info Libr J, 26*(2), 91-108.

Grewal, R., & Slotegraaf, R. J. (2007). Embeddedness of organizational capabilities. *Decision Sciences, 38*(3), 451-488.

Gueguen, G., & Torrès, O. (2004). La dynamique concurrentielle des écosystèmes d'affaires. Linux contre Microsoft. *Revue française de gestion, 30*(148), 227-248. doi:10.3166/rfg.148.227-248

Hahn, T. (2015). *Cross-industry innovation processes: strategic implications for telecommunication companies*: Springer.

Haines, S. G., & McKinlay, J. (2007). *Reinventing Strategic Planning: The Systems Thinking Approach*: Systems Thinking Press.

Hannes, K., & Lockwood, C. (2011a). Pragmatism as the philosophical foundation for the Joanna Briggs meta-aggregative approach to qualitative evidence synthesis. *Journal of Advanced Nursing, 67*(7), 1632-1642.

Hannes, K., & Lockwood, C. (2011b). *Synthesizing qualitative research: choosing the right approach*: John Wiley & Sons.

Hauschild, M. (2017, Posted on 9 Nov 2017). How to create value beyond the traditional supply chain. *The Mnufacturer*.

Hayes, R. H., Gary P. Pisano, David M. Upton, & Wheelwright, S. C. (2004). *Operations, Strategy, and Technology: Pursuing the Competitive Edge*. Indianapolis: John Wiley & Sons.

Hellström, M., Tsvetkova, A., Gustafsson, M., & Wikström, K. (2015). Collaboration mechanisms for business models in distributed energy ecosystems. *Journal of Cleaner Production, 102* 226-236. Retrieved from http://www.sciencedirect.com/science/article/pii/S095965261500503X

Henderson, B. (1989). The Origin of the Strategy. *Harvard Business Review*.

Heracleous, L. (1998). Strategic thinking or strategic planning? *Long range planning, 31*(3), 481-487.

Heuer, M. (2011). Ecosystem cross-sector collaboration: conceptualizing an adaptive approach to sustainability governance. *Business Strategy and the Environment, 20*(4), 211-221. doi:10.1002/bse.673

Hidalgo, A., & Albors, J. (2008). Innovation management techniques and tools: a review from theory and practice. *R&D Management, 38*(2), 113-127. doi:10.1111/j.1467-9310.2008.00503.x

Hirose, Y., Phaal, R., & Probert, D. (2015). *A Conceptual Framework for Exploring the Scalable Integration of Roadmapping and Innovation System Functions for Industrial Emergence*. Paper presented at the DRUID Academy conference in Rebild, Aalborg, Denmark.

Hitoshi, A., Akihiko, S., Minoru, E., Shigeki, S., & Shunichi, K. (2008, 27-31 July 2008). *Towards systematic innovation methods: Innovation support technology that integrates business modeling, roadmapping and innovation architecture.* Paper presented at the PICMET '08 - 2008 Portland International Conference on Management of Engineering & Technology (pp. 2141-2149).doi:DOI

Hodgson, G. M. (1993). *Economics and evolution: bringing life back into economics*: University of Michigan Press.

Hodgson, G. M., Samuels, W. J., & Tool, M. R. (1994). Evolutionary economics. In. Aldershot, Hants, England ; Brookfield, Vt., USA: E. Elgar.

Hwang, V. W., & Mabogunje, A. (2013). The New Economics of Innovation Ecosystems. *Stanford Social Innovation Review (SSIR)*.

Iansiti, M. (2004). Keystones and Dominators: Framing Operating and Technology Strategy in a Business Ecosystem (pp. 83).

Iansiti, M., & Levien, R. (2002). *The New Operational Dynamics of Business Ecosystems: Implications for Policy, Operations and Technology Strategy* Harvard Business School Retrieved from http://www.hbs.edu/faculty/Publication%20Files/03-030_9bfcbb1b-85a1-4e1b-9f73-41bea8f63821.pdf

Iansiti, M., & Levien, R. (2004a). Creating Value in Your Business Ecosystem. *Harvard Business Review*. Retrieved from http://hbswk.hbs.edu/item/creating-value-in-your-business-ecosystem

Iansiti, M., & Levien, R. (2004). *The keystone advantage : what the new dynamics of business ecosystems mean for strategy, innovation, and sustainability*. Boston, Mass.: Harvard Business School Press.

Iansiti, M., & Levien, R. (2004b). Strategy as ecology. *Harvard Business Review, 82*(3), 68-+.

Igartua-Lopez, J. I., Albors, J., & Hervas-Oliver, J. L. (2010). How innovation management techniques support r&d open innovation strategy. *Research Technology Management 53*(3), 41-52.

Ilevbare, I., Phaal, R., Probert, D., & Padilla, A. T. (2011). Integration of TRIZ and roadmapping for innovation, strategy, and problem solving. *Centre for Technology Management*. Retrieved from https://www.ifm.eng.cam.ac.uk/uploads/Research/CTM/Roadmapping/triz_dux_trt_phase1_report.pdf

INCOSE. (2006). *Systems Engineering Handbook*. USA: International Council on Systems Engineering.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. *Strategic Management Journal, 39*(8), 2255-2276.

Jacobides, M. G., Kapoor, R., Eisenhardt, K., Gawer, A., Hannah, D., & Ahuja, G. (2018). Shaping Sectors, Changing Architectures, Constructing Ecosystems. *Academy of Management Proceedings, 2018*(1), 12100.

Jarzabkowski, P., & Kaplan, S. (2015). Strategy tools-in-use: A framework for understanding "technologies of rationality" in practice. *Strategic Management Journal, 36*(4), 537-558.

Jensen, M. B., Johnson, B., Lorenz, E., & Lundvall, B. Å. (2007). Forms of knowledge and modes of innovation. *The Learning Economy and the Economics of Hope, 155*.

Jeong, Y., & Yoon, B. (2015). Development of patent roadmap based on technology roadmap by analyzing patterns of patent development. *Technovation, 39-40* 37-52. doi:10.1016/j.technovation.2014.03.001

Jones, P. (2012). *Toward the Integration of Visual Languages for Systemic Design*. OCAD University Open Research Repository. Retrieved from http://openresearch.ocadu.ca/902/1/Toward_the_Integration_of_Visual_Languag.pdf

Jones, P. H., Christakis, A. N., & Flanagan, T. R. (2007). Dialogic design for the intelligent enterprise: Collaborative strategy, process, and action: INCOSE.

Jonker, J., & Pennink, B. (2010). *The essence of research methodology*: Springer-Verlag Berlin.

Kamtsiou, V. E., Olivier, B., Derntl, M., Millwood, R., & Naeve, A. (2013). Dynamic Roadmapping - Managing Innovation in Turbulent Times *An implementation guide for roadmapping practitioners*: Pan European Observatory for Innovation.

Kanama, D., Kondo, A., & Yokoo, Y. (2008). Development of technology foresight: integration of technology roadmapping and the Delphi method. *International Journal of Technology Intelligence and Planning, 4*(2), 184-200. doi:10.1504/ijtip.2008.018316

Kandiah, G., & Gossain, S. (1998). Reinventing value: The new business ecosystem. *Strategy & Leadership, 26*(5), 28-33. doi:10.1108/eb054622

Kapoor, R., & Lee, J. M. (2013). Coordinating and competing in ecosystems: How organizational forms shape new technology investments. *Strategic Management Journal, 34*(3), 274-296. doi:10.1002/smj.2010

Karimi-Shahanjarini, A., Shakibazadeh, E., Rashidian, A., Hajimiri, K., Glenton, C., Noyes, J., . . . Colvin, C. J. (2019). Barriers and facilitators to the implementation of doctor-nurse substitution strategies in primary care: a qualitative evidence synthesis. *Cochrane Database of Systematic Reviews*(4).

Kastalli, I. V., & Neely, A. (2014). *Collaborate to innovate - How Business Ecosystems Unleash Business Value*. University of Cambridge.

Kaufmann-Hayoz, R., Bättig, C., Bruppacher, S., Defila, R., Di Giulio, A., Flury-Kleubler, P., . . . Jäggi, C. (2001). A typology of tools for building sustainability strategies. In *Changing Things—Moving People* (pp. 33-107): Springer.

Keer, C., & Phaal, R. (2015). Management tools and toolkits: the good, the bad and the ugly. *Institute for Manufacturing Review,* (3), 9-11. Retrieved from https://www.ifm.eng.cam.ac.uk/research/ifm-review/

Kerr, C., Farrukh, C., Phaal, R., & Probert, D. (2013). Key principles for developing industrially relevant strategic technology management toolkits. *Technological Forecasting and Social Change, 80*(6), 1050-1070. doi:10.1016/j.techfore.2012.09.006

Kitchenham, B., Pickard, L., & Pfleeger, S. L. (1995). Case studies for method and tool evaluation. *IEEE Software, 12*(4), 52-62. doi:10.1109/52.391832

Knott, P. (2008). Strategy tools: who really uses them? *Journal of Business Strategy, 29*(5), 26-31. doi:10.1108/02756660810902297

Kœnig, G. (2012). Le concept d'écosystème d'affaires revisité. *M@n@gement, 15*(2), 209. doi:10.3917/mana.152.0209

Koivisto, R., Wessberg, N., Eerola, A., Ahlqvist, T., Kivisaari, S., Myllyoja, J., & Halonen, M. (2009). Integrating future-oriented technology analysis and risk assessment methodologies. *Technological Forecasting and Social Change, 76*(9), 1163-1176. Retrieved from http://www.sciencedirect.com/science/article/pii/S0040162509001085

Komssi, M., Kauppinen, M., Töhönen, H., Lehtola, L., & Davis, A. M. (2011, 29 Aug.-2 Sept. 2011). *Integrating analysis of customers' processes into roadmapping: The value-creation perspective.* Paper presented at the 2011 IEEE 19th International Requirements Engineering Conference (pp. 57-66).doi:DOI

Kostoff, R. N., & Scaller, R. R. (2001). Science and technology roadmaps. *Ieee Transactions on Engineering Management, 48*(2), 132-143. doi:Doi 10.1109/17.922473

Kristensen, K., & Ucler, C. (2016). *Collaboration Model Canvas: Using the Business Model Canvas to Model Productive Collaborative Behavior*. Paper presented at the 22nd ICE / 2016 IEEE TMC Europe Conference, Trondheim, Norway.

Kuechler, B., & Vaishnavi, V. (2008). On theory development in design science research: anatomy of a research project. *European Journal of Information Systems, 17*(5), 489-504.

Lappi, T., Haapasalo, H., & Aaltonen, K. (2015). Business Ecosystem Definition in Built Environment Using a Stakeholder Assessment Process (Vol. 10, pp. 110-129): University of Primorska, Faculty of Management Koper - Management (18544223) - Summer2015.

Laudien, S. M., & Daxböck, B. (2016). Business model innovation processes of average market players: a qualitative-empirical analysis. *R&D Management* n/a-n/a. doi:10.1111/radm.12208

Leavy, B. (2012). Interview – Ron Adner: managing the interdependencies and risks of an innovation ecosystem. *Strategy & Leadership, 40*(6), 14-21. doi:10.1108/10878571211278840

Lee, S., & Park, Y. (2005). Customization of technology roadmaps according to roadmapping purposes: Overall process and detailed modules. *Technological Forecasting and Social Change, 72*(5), 567-583. doi:10.1016/j.techfore.2004.11.006

Leontief, W. (1941). *The structure of American economy, 1919-1929; an empirical application of equilibrium analysis*. Cambridge, Mass.,: Harvard University Press.

Letaifa, B., Gratacap, A. S., & Isckia, T. (2013). *Understanding Business Ecosystems: How Firms Succeed in the New World of Convergence?* Brussels: De Boeck.

Li, X., Zhou, Y., Xue, L., & Huang, L. (2015). Integrating bibliometrics and roadmapping methods: A case of dye-sensitized solar cell technology-based industry in China. *Technological Forecasting and Social Change, 97* 205-222. Retrieved from http://www.sciencedirect.com/science/article/pii/S0040162514001644

Li, Y.-R. (2009). The technological roadmap of Cisco's business ecosystem. *Technovation, 29*(5), 379-386. Retrieved from http://www.sciencedirect.com/science/article/pii/S0166497209000157

Li, Y.-R. (2011). Visualization of the Technological Evolution of the DVD Business Ecosystem. In R. Katarzyniak, T.-F. Chiu, C.-F. Hong & N. T. Nguyen (Eds.), *Semantic Methods for Knowledge Management and Communication* (pp. 231-237). Berlin, Heidelberg: Springer Berlin Heidelberg.

Liao, P.-C., Zhang, K., Wang, T., & Wang, Y. (2016). Integrating bibliometrics and roadmapping: A case of strategic promotion for the ground source heat pump in China. *Renewable and Sustainable Energy Reviews, 57* 292-301. Retrieved from http://www.sciencedirect.com/science/article/pii/S136403211501463X

Lichtenthaler, U. (2008). Integrated roadmaps for open innovation. *Research-Technology Management, 51*(3), 45-49.

Liddell, H. G., & Scott, R. (Eds.). (2016). *A Greek-English Lexicon*.

Liedtka, J. M. (1998). Strategic thinking: Can it be taught? *Long Range Planning, 31*(1), 120-129. Retrieved from http://www.sciencedirect.com/science/article/pii/S0024630197000988

List, F. (1841). *The National System of Political Economy*. London: Longmans, Green and Co.

Londo, H. M., More, E., Phaal, R., Würtenberger, L., & Cameron, L. (2013). Background paper on Technology Roadmaps (TRMs). Bonn, Germany: Energy research Centre of the Netherlands (ECN).

Lopez-Ortega, E., Concepcion, T. A., & Viloria, S. B. (2006, 8-13 July 2006). *Strategic Planning, Technology Roadmaps and Technology Intelligence: An Integrated Approach.* Paper presented at the 2006 Technology Management for the Global Future - PICMET 2006 Conference (Vol. 1, pp. 27-33).doi:DOI

Lundvall, B. A. (1985). Product Innovation and User-Producer Interaction. In I. D. R. Series (Ed.), *Industrial Development Research Series*. DK: Aalborg University Press

Lundvall, B. A. (1992). *National systems of innovation : towards a theory of innovation and interactive learning*. London and New York: Distributed exclusively in the USA and Canada by St. Martin's Press.

Lundvall, B. A. (2005). *Dynamics of Industry and Innovation: Organizations, Networks and Systems* Paper presented at the DRUID-conference Copenhagen, Denmark. Retrieved from http://www.druid.dk/conferences/Summer2005/Papers/Lundvall.pdf

Lundvall, B. A. (2007a). Innovation System Research Where it came from and where it might go. Retrieved from http://www.globelicsacademy.org/2011_pdf/Lundvall_(post%20scriptum).pdf

Lundvall, B. A. (2007b). National innovation systems—analytical concept and development tool. *Industry and innovation, 14*(1), 95-119.

Lundvall, B. A., Johnson, B., Andersen, E. S., & Dalum, B. (2002). National systems of production, innovation and competence building. *Research Policy, 31*(2), 213-231. Retrieved from http://www.sciencedirect.com/science/article/pii/S0048733301001378

Majava, J., Isoherranen, V., & Kess, P. (2013). Business Collaboration Concepts and Implications for Companies. *International Journal of Synergy and Research, Vol. 2, No. 1, 2013* 23–40.

Mansfield, H. (2016). Niccolò Machiavelli - Italian statesman and writer. Retrieved from https://www.britannica.com/biography/Niccolo-Machiavelli#ref161773

Martin G. Moehrle, R. I., Robert Phaal. (2013). *Technology Roadmapping for Strategy and Innovation - Charting the Route to Success*: Springer-Verlag Berlin Heidelberg.

Massey, A. P., & Wallace, W. A. (1996). Understanding and facilitating group problem structuring and formulation: Mental representations, interaction, and representation aids. *Decision Support Systems, 17*(4), 253-274. doi:Doi 10.1016/0167-9236(96)00004-8

McIntyre, D. P., & Srinivasan, A. (2016). Networks, platforms, and strategy: Emerging views and next steps. *Strategic Management Journal, 38*(1), 141-160. doi:10.1002/smj.2596

McKinsey. (2013). Disruptive technologies: Advances that will transform life, business, and the global economy.

McKinsey. (2015). *Unlocking the potential of the Internet of Things*. McKinsey&Company.

Metcalfe, S. (1995). The economic foundations of technology policy. *Handbook of the economics of innovation and technological change* 409-512.

Mika, W., Seppo, L., & Mervi, R. (2014). Designing Business Models for the Internet of Things. *Technology Innovation Management Review, 4*(7). Retrieved from http://timreview.ca/article/807

Mintzberg, H. (2008). *Tracking Strategies: Towards a General Theory of Strategy Formation*.

Mintzberg, H., Ahlstrand, B., & Lampel, J. (2005). *Strategy Safari: a guided tour through the wilds of strategic mangament*: Simon and Schuster.

Mintzberg, H., Lampel, J., & Ahlstrand, B. (1998). *Strategy Safary: a guided tour through the wilds of strategic management*: The Free Press.

Miyamoto, M., & Harris, V. (1982). *A book of five rings*: Allison and Busby.

Moore, J. (1993). Predators and Prey - A New Ecology of Competition. *Harvard Business Review, 71*(3), 75-86. Retrieved from https://hbr.org/1993/05/predators-and-prey-a-new-ecology-of-competition/ar/1

Moore, J. (1996). *The death of competition : leadership and strategy in the age of business ecosystems* (1st ed.). New York: HarperBusiness.

Moore, J. (1998). The rise of a new corporate form. *The Washington Quarterly, 21*(1), 167-181. doi:10.1080/01636609809550301

Moore, J. (2013). *Shared Purpose: A thousand business ecosystems, a connected community, and the future* CreateSpace Independent Publishing Platform.

More, E., Gungor, Z. E., Phaal, R., & Probert, D. (2015). Addressing Resource Over-exploitation Via Cooperative Institutions: Examining How Technology Roadmapping Could Contribute. *Procedia CIRP, 26*(0), 173-178. Retrieved from http://www.sciencedirect.com/science/article/pii/S2212827114009214

Myers, J. L. (2007). *Integration of technology roadmapping information into DMSMS-driven design refresh planning of the V-22 Advanced Mission Computer*. (University of Maryland, College Park).

Nachira, F., Nicolai, A., Dini, P., Le Louarn, M., & Leon, L. R. (2006). *Digital Business Ecosystems*: European Commission.

Nambisan, S., & Baron, R. A. (2013). Entrepreneurship in innovation ecosystems: entrepreneurs' self-regulatory processes and their implications for new venture success. *Entrepreneurship Theory and Practice, 37*(5), 1071-1097.

Nelson, R., & Winter, S. (1977). In search of useful theory of innovation. *Research Policy, 6* 36-76.

Nelson, R., & Winter, S. (1982). *An evolutionary theory of economic change*. Cambridge, Mass.: Belknap Press of Harvard University Press.

Nelson, R. R. (1993). *National Innovation Systems: A Comparative Analysis*: Oxford University Press.

Nikayin, F. A. (2014). *Common Platform Dilemmas: Collective Action and the Internet of Things.* (University of Malaya, Iran).

Nimmo, G. (2003). *Technology Roadmapping - A strategy for Success*. Retrieved from http://www.apecforesight.org/publications/TRMThailand.pdf

Nimmo, G. (2013). Technology Roadmapping on the Industry Level: Experiences from Canada. In M. G. Moehrle, R. Isenmann & R. Phaal (Eds.), *Technology Roadmapping for Strategy and Innovation* (pp. 47-65): Springer Berlin Heidelberg.

Niosi, J. (2011). Building innovation systems: an introduction to the special section. *Industrial and Corporate Change, 20*(6), 1637-1643. doi:10.1093/icc/dtr064

Niosi, J., Saviotti, P., Bellon, B., & Crow, M. (1993). National systems of innovation: in search of a workable concept. *Technology in Society, 15*(2), 207-227. Retrieved from http://www.sciencedirect.com/science/article/pii/0160791X93900037

OECD. (1997). National Innovation Systems. Paris: OECD Publishing.

OECD. (2013). *Interconnected economies: Benefiting from Global Value Chains - Synthesis Report*. OECD Publishing. Retrieved from http://www.oecd.org/sti/ind/interconnected-economies-GVCs-synthesis.pdf

OECD. (2015). OECD Digital Economy Outlook 2015.pdf. Paris: OECD Publishing.

Oh, D.-S., Phillips, F., Park, S., & Lee, E. (2016). Innovation ecosystems: A critical examination. *Technovation*. doi:http://dx.doi.org/10.1016/j.technovation.2016.02.004

Oliveira, M. G., & Rozenfeld, H. (2010). Integrating technology roadmapping and portfolio management at the front-end of new product development. *Technological Forecasting and Social Change, 77*(8), 1339-1354. Retrieved from http://www.sciencedirect.com/science/article/pii/S0040162510001782

Osterwalder, A., Pigneur, Y., Bernarda, G., Smith, A., & Papadakos, T. (2014). *Value Proposition Design: How to Create Products and Services Customers Want*: Wiley.

Osterwalder, A., Pigneur, Y., & Clark, T. (2010). *Business model generation : a handbook for visionaries, game changers, and challengers*. Hoboken, NJ: Wiley.

Overholm, H. (2015). Collectively created opportunities in emerging ecosystems: The case of solar service ventures. *Technovation, 39*(Supplement C), 14-25. doi:https://doi.org/10.1016/j.technovation.2014.01.008

Parisot, X., & Thierry, I. (2017a). La théorie substantive des écosystèmes d'affaires selon James Moore.

Parisot, X., & Thierry, I. (2017b). Une lecture Lakatosienne de l'approche par les Ecosystemes d'affaires.

Parker, G., & Alstyne, M. V. (2018a). Innovation, Openness, and Platform Control. *Management Science, 64*(7), 3015-3032. doi:10.1287/mnsc.2017.2757

Parker, G., Alstyne, M. V., & Evans, P. (2018b). How Platform Strategies Continue to Create Value - Lessons for business leaders from the 2018 MIT Platform Strategy Summit: MIT Sloan Management Review.

Paroutis, S., Franco, L. A., & Papadopoulos, T. (2015). Visual Interactions with Strategy Tools: Producing Strategic Knowledge in Workshops. *British Journal of Management, 26*(S1), S48-S66. doi:10.1111/1467-8551.12081

Parrish, S., & Beaubien, R. (2019). *The Great Mental Models: General Thinking Concepts*: Latticework Publishing Inc.

Patel, P. (1994). The nature and economic importance of national innovation systems. *STI review, 14* 9-32.

Pavitt, K. (1984). Sectoral patterns of technical change: Towards a taxonomy and a theory. *Research Policy, 13*(6), 343-373. Retrieved from http://www.sciencedirect.com/science/article/pii/0048733384900180

Pellegrin-Boucher, E., & Gueguen, G. (2005). Stratégies de « coopétition » au sein d'un écosystème d'affaires : une illustration à travers le cas de SAP. *Finance Contrôle Stratégie, 8*(1), 109 – 130.

Peltoniemi, M. (2006). Preliminary theoretical framework for the study of business ecosystems. *Emergence: Complexity and Organization*. doi:10.emerg/10.17357.8bb81e60d0fa815f83002ae1f418068c

Peltoniemi, M. (2014). *Cluster, Value Network and Business Ecosystem: Knowledge and Innovation Approach*. Paper presented at the "Organisations, Innovation and Complexity: New Perspectives

on the Knowledge Economy", University of Manchester

Peltoniemi, M., & Vuori, E. (2004). *Business ecosystem as the new approach to complex adaptive business environments.* Paper presented at the Proceedings of eBusiness Research Forum.doi:DOI

Peltoniemi, M., Vuori, E., & Laihonen, H. (2005). Business ecosystem as a tool for the conceptualisation of the external diversity of an organisation.

Phaal, R. (2003). *Fast-start technology roadmapping*. Prague: University of Cambridge.

Phaal, R. (2018). Roadmapping Bibliography. Centre for Technology ManagementDepartment of Engineering: University of Cambridge.

Phaal, R. (2019). Cambridge roadmapping - Strategy toolkits. Retrieved from https://www.cambridgeroadmapping.net

Phaal, R., Farrukh, C., & Probert, D. (2001). *T-Plan: the fast-start to technology roadmapping: planning your route to success*: University of Cambridge, Institute for Manufacturing.

Phaal, R., Farrukh, C., & Probert, D. (2001). Technology roadmapping: linking technology resources to business objectives.

Phaal, R., Farrukh, C., & Probert, D. (2006a). Technology management tools: generalization, integration and configuration. *International Journal of Innovation and Technology Management, 3*(03), 321-339.

Phaal, R., Farrukh, C., & Probert, D. R. (2000, 2000). *Tools for technology management-structure, organisation and integration.* Paper presented at the Management of Innovation and Technology, 2000. ICMIT 2000. Proceedings of the 2000 IEEE International Conference on (Vol. 1, pp. 224-229 vol.221).doi:DOI

Phaal, R., Farrukh, C. J. P., Mills, J. F., & Probert, D. R. (2003, 24-24 July 2003). *Customizing the technology roadmapping approach.* Paper presented at the PICMET '03: Portland International Conference on Management of Engineering and Technology Technology Management for Reshaping the World, 2003. (pp. 361-369).doi:DOI

Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2004). Technology roadmapping—A planning framework for evolution and revolution. *Technological Forecasting and Social Change, 71*(1-2), 5-26. doi:10.1016/s0040-1625(03)00072-6

Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2006b). Technology management tools: concept, development and application. *Technovation, 26*(3), 336-344. doi:10.1016/j.technovation.2005.02.001

Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2007). Strategic roadmapping: A workshop-based approach for identifying and exploring strategic issues and opportunities. *Emj-Engineering Management Journal, 19*(1), 3-12.

Phaal, R., Kerr, C., Ilevbare, I., Farrukh, C., Routley, M., & Athanassopolou, N. (2015). *Self-facilitating templates for technology and innovation strategy workshops*. Paper presented at the R&D Conference, Pisa.

Phaal, R., Kerr, C., Ilevbare, I., Farrukh, C., Routley, M., & Athanassopoulou, N. (2016). *On 'self-facilitating' templates for technology and innovation strategy workshops*. Paper presented at the R&D Management Conference, Pisa.

Phaal, R., O'Sullivan, E., Routley, M., Ford, S., & Probert, D. (2011). A framework for mapping industrial emergence. *Technological Forecasting and Social Change, 78*(2), 217-230. doi:10.1016/j.techfore.2010.06.018

Phaal, R., & Palmer, P. J. (2010). Technology Management—Structuring the Strategic Dialogue. *Engineering Management Journal, 22*(1), 64-74. doi:10.1080/10429247.2010.11431854

Phaal, R., & Probert, D. (2009). *Technology roadmapping: facilitating collaborative research strategy*. Centre for Technology Management - Department of Engineering. University of Cambridge.

Phaal, R., Probert, D., Farrukh, C., & Dissel, M. (2015). Value Roadmapping. *US9S-6308/09/S5.00*

Phaal, R., Probert, D., Routley, M., & O'Sullivan, E. (2011). Industry Scan - Guidance for mapping historical industrial emergence, evolution, development and change.

Piepenbrock, T. F. (2009). *Toward a theory of the evolution of Business Ecosytem.* (MIT - Massachusetts Institute of Technology).

Pilinkiene, V., & Maciulis, P. (2014). Comparison of different ecosystem analogies: the main economic determinants and levels of impact. *19th International Scientific Conference Economics and Management 2014 (Icem-2014), 156* 365-370.

Pilinkienė, V., & Mačiulis, P. (2014). Comparison of Different Ecosystem Analogies: The Main Economic Determinants and Levels of Impact. *Procedia - Social and Behavioral Sciences, 156* 365-370. Retrieved from http://www.sciencedirect.com/science/article/pii/S1877042814060248

Platts, K. W. (1993). A process approach to researching manufacturing strategy. *International Journal of Operations & Production Management, 13*(8), 4-17.

Polit, D. F., & Beck, C. T. (2014). *Essentials of nursing research : appraising evidence for nursing practice* (8th ed.). Philadelphia: Wolters Kluwer Health /Lippincott Williams & Wilkins.

Porter, M. E. (1990). *The competitive advantage of nations*. New York: Free Press.

Rakas, M., & Hain, D. S. (2016). *The Development of Innovation System Research: Towards an Interdisciplinary and Multidimensional Approach?* Paper presented at the The International Joseph Alois Schumpeter Society Conference 2016, Montreal.doi:DOI

Ranga, M., & Etzkowitz, H. (2013). Triple Helix systems: an analytical framework for innovation policy and practice in the Knowledge Society. *Industry and Higher Education, 27*(4), 237-262.

Reid, B. H. (2014). The Legacy of Liddell Hart: The Contrasting Responses of Michael Howard and André Beaufre. *British Journal for Military History, 1*(1). Retrieved from bjmh.org.uk/index.php/bjmh/article/download/7/7

Remneland, B., & Wikhamn, W. (2013). Structuring of the Open Innovation Field. *Journal of technology management & innovation, 8* 173-185.

Riedl, C., May, N., Finzen, J., Stathel, S., Kaufman, V., & Krcmar, H. (2011). An idea ontology for innovation management. In *Semantic Services, Interoperability and Web Applications: Emerging Concepts* (pp. 303-321): IGI Global.

Ritala, P., Agouridas, V., Assimakopoulos, D., & Gies, O. (2013). Value creation and capture mechanisms in innovation ecosystems: a comparative case study. *International Journal of Technology Management, 63*(3-4), 244-267. doi:10.1504/ijtm.2013.056900

Ritala, P., & Almpanopoulou, A. (2017). In defense of 'eco' in innovation ecosystem. *Technovation, 60-61* 39-42. doi:https://doi.org/10.1016/j.technovation.2017.01.004

Robert Phaal, Clare J.P. Farrukh, & Probert, D. R. (2000). *Fast-Start Technology Roadmapping*. Paper presented at the IAMOT 2000.

Robert Phaal, Clare J.P. Farrukh, & Probert, D. R. (2005). Developing a Technology Roadmapping System. *Technology Management* 99-111.

Rong, K., Hou, J., Shi, Y., & Lu, Q. (2010, 7-10 Dec. 2010). *From value chain, supply network, towards business ecosystem (BE): Evaluating the BE concept's implications to emerging industrial demand.* Paper presented at the Industrial Engineering and Engineering Management (IEEM), 2010 IEEE International Conference on (pp. 2173-2177).doi:DOI

Rong, K., Hu, G., Lin, Y., Shi, Y., & Guo, L. (2015a). Understanding business ecosystem using a 6C framework in Internet-of-Things-based sectors. *International Journal of Production*

Economics, 159(0), 41-55. Retrieved from http://www.sciencedirect.com/science/article/pii/S0925527314002813

Rong, K., Hu, G., Lin, Y., Shi, Y., & Guo, L. (2015b). Understanding business ecosystem using a 6C framework in Internet-of-Things-based sectors. *International Journal of Production Economics, 159* 41-55. doi:http://dx.doi.org/10.1016/j.ijpe.2014.09.003

Rong, K., Lin, Y., Shi, Y., & Yu, J. (2013a). Linking business ecosystem lifecycle with platform strategy: a triple view of technology, application and organisation. *International Journal of Technology Management, 62*(1), 75. doi:10.1504/ijtm.2013.053042

Rong, K., & Shi, Y. (2009). Constructing Business Ecosystem from Firm Perspective: Cases in High-tech Industry.

Rong, K., & Shi, Y. (2015c). *Business Ecosystems - Constructs, Configurations, and the Nurturing Process*: Palgrave Macmillan.

Rong, K., Shi, Y., & Yu, J. (2013b). Nurturing business ecosystems to deal with industry uncertainties. *Industrial Management & Data Systems, 113*(3), 385-402. doi:10.1108/02635571311312677

Rothschild, M. L. (1990). *Bionomics : the inevitability of capitalism* (1st ed.). New York: H. Holt.

Sábato, J., & Botana, N. (1968). La ciencia y la tecnologia en el desarollo futuro de América Latina [Science and technology in the future development of Latin America]. *Revista de la Integración, 3* 15-36.

Sacchetti, S., & Tortia, E. (2016). THE EXTENDED GOVERNANCE OF COOPERATIVE FIRMS: INTER-FIRM COORDINATION AND CONSISTENCY OF VALUES. *Annals of Public and Cooperative Economics, 87*(1), 93-116. doi:10.1111/apce.12058

Saritas, O., & Oner, M. A. (2004). Systemic analysis of UK foresight results: Joint application of integrated management model and roadmapping. *Technological Forecasting and Social Change, 71*(1), 27-65. Retrieved from http://www.sciencedirect.com/science/article/pii/S0040162503000672

Savioz, P., & Blum, M. (2002). Strategic forecast tool for SMEs: how the opportunity landscape interacts with business strategy to anticipate technological trends. *Technovation, 22*(2), 91-100. Retrieved from http://www.sciencedirect.com/science/article/pii/S0166497201000827

SFCED. (2015). The World's Most Innovative Companies are in San Francisco. Retrieved from http://sfced.org/1150-of-the-worlds-most-innovative-companies-are-in-san-francisco/

Shaughnessy, H. (2014). Crowdsourcing the ecosystem's expectations: a decision-making process to manage the unmanageable. *Strategy & Leadership, 42*(3), 3-8. doi:10.1108/sl-03-2014-0022

Shehabuddeen, N., Probert, D., & Phaal, R. (2006). From theory to practice: challenges in operationalising a technology selection framework. *Technovation, 26*(3), 324-335. doi:http://dx.doi.org/10.1016/j.technovation.2004.10.017

Shi, Y., Fleet, D., & Gregory, M. (2003). Global manufacturing virtual network (GMVN): A revisiting of the concept after three years fieldwork. *Journal of Systems Science and Systems Engineering, 12*(4), 432-448. doi:10.1007/s11518-006-0146-2

Simandan, D. (2012). Options for Moving beyond the Canonical Model of Regional Path Dependence. *International Journal of Urban and Regional Research, 36*(1), 172-178. doi:doi:10.1111/j.1468-2427.2011.01090.x

Snyder, N. T., & Duarte, D. L. (2003). *Strategic innovation: embedding innovation as a core competency in your organization*: John Wiley & Sons.

Soete, L., Verspagen, B., & Weel, B. t. (2009). Systems of Innovation. Maastricht: United Nations University

Sordi, J. O. D., Azevedo, M. C., & Meirles, M. (2015). A Pesquisa Design Science no Brasil segundo as Publicações em Administração da Informação. *Journal of Information Systems and Technology Management, 12*(1). doi:10.4301/s1807-17752015000100009

Spee, A. P., & Jarzabkowski, P. (2009). Strategy tools as boundary objects. *Strategic Organization, 7*(2), 223-232.

Steven, D., Martin, H., & Anthony, M. (2015). Strategies for creating and capturing value in the emerging ecosystem economy. *Strategy & Leadership, 43*(2), 2-10. doi:doi:10.1108/SL-01-2015-0003

Steven, M. (2013). Platforms, Communities, and Business Ecosystems: Lessons Learned about Technology Entrepreneurship in an Interconnected World. *Technology Innovation Management Review, 3*(2). Retrieved from http://timreview.ca/article/655

Stolwijk, C. C. M., Ortt, J. R., & den Hartigh, E. (2013). The joint evolution of alliance networks and technology: A survey of the empirical literature. *Technological Forecasting and Social Change, 80*(7), 1287-1305. doi:10.1016/j.techfore.2012.11.012

Strauss, J., Radnor, M., & Peterson, J. (1998). *Plotting and navigating a non-linear roadmap: knowledge-based roadmapping for emerging and dynamic environments*. Paper presented at the Proceedings of the East Asian conference on knowledge creation management.

Strikwerda, J. (2010). Execution: Creating new innovative strategic behavior. In G. A. Damen, J. Dubel & J. Strikwerda (Eds.), *New Strategic Behavior: Managing your context* Nolan, Norton & Co.

Stringer, E. T. (2007). *Action research* (3rd ed.). Los Angeles: Sage Publications.

Suomalainen, T., Salo, O., Abrahamsson, P., & Similä, J. (2011). Software product roadmapping in a volatile business environment. *Journal of Systems and Software, 84*(6), 958-975. Retrieved from http://www.sciencedirect.com/science/article/pii/S0164121211000239

Talmar, M., Walrave, B., Podoynitsyna, K. S., Holmström, J., & Romme, A. G. L. (2018). Mapping, analyzing and designing innovation ecosystems: The Ecosystem Pie Model. *Long Range Planning*. Retrieved from http://www.sciencedirect.com/science/article/pii/S0024630118304667

Täuscher, K., & Laudien, S. M. (2018). Understanding platform business models: A mixed methods study of marketplaces. *European Management Journal, 36*(3), 319-329. doi:https://doi.org/10.1016/j.emj.2017.06.005

Teece, D. J. (2015). Business Ecosystem - Incorporating Value Network. In *The Palgrave Encyclopedia of Strategic Management* (pp. 3). doi:10.1057/9781137294678.0190

Teixeira de Melo, A., Caves, L. S. D., Dewitt, A., Clutton, E., Macpherson, R., & Garnett, P. (2019). Thinking (in) complexity:(In) definitions and (mis) conceptions. *Systems Research and Behavioral Science*.

Thompson, V., Decker, B., Hardash, J. A. C., & Summers, R. O. (2012, 3-10 March 2012). *NASA (In)novation Ecosystem: Taking technology innovation from buzz to reality*. Paper presented at the Aerospace Conference, 2012 IEEE (pp. 1-9).doi:DOI

Tian, C. H., Ray, B. K., Lee, J., Cao, R., & Ding, W. (2008). BEAM: A framework for business ecosystem analysis and modeling. *IBM Systems Journal, 47*(1), 101-114. doi:10.1147/sj.471.0101

Toporowski, J., & Freeman, A. (2010). Professor Christopher Freeman: Influential economist whose radical views gave him a healthy suspicion of capitalism. *The Independent*.

Toro-Jarrín, M. A., Ponce-Jaramillo, I. E., & Güemes-Castorena, D. (2016). Methodology for the of building process integration of Business Model Canvas and Technological Roadmap. *Technological Forecasting and Social Change, 110* 213-225. Retrieved from http://www.sciencedirect.com/science/article/pii/S004016251600010X

Torre, A., & Zimmermann, J. B. (2015). Des clusters aux écosystèmes industriels locaux. *Revue d'Économie Industrielle,, 52* 13 - 38.

Tsvetkova, A., & Gustafsson, M. (2012). Business models for industrial ecosystems: a modular approach. *Journal of Cleaner Production, 29–30*(0), 246-254. Retrieved from http://www.sciencedirect.com/science/article/pii/S0959652612000297

Tuomo Kinnunen, K. S., Janne Harkonen, Harri Haapasalo. (2013). Business Ecosystem Perspective to New Product Development. *International Journal of Business Development and Research, 1, Number 1*.

Tzu, S. (2002). *The Art of War*: Dover Publications.

Uhlemann, T. H.-J., Schock, C., Lehmann, C., Freiberger, S., & Steinhilper, R. (2017). The digital twin: demonstrating the potential of real time data acquisition in production systems. *Procedia Manufacturing, 9* 113-120.

Urmetzer, F. (2014). Ecosystems Value Mapping and Analysis.

Urmetzer, F. (2015). Creating and capturing value in business ecosystems. Cambridge, UK: University of Cambridge.

Urmetzer, F., Neely, A., & Martinez, V. (2016). *The Ecosystem Value Framework: Supporting Managers to Understand Value Exchange between Core Businesses in Service Ecosystems*. Paper presented at the EurOMA 2016, Trondheim, Norway.

Valkokari, K. (2015). *Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them* (Vol. 5).

Valkokari, K., Seppänen, M., Mäntylä, M., & Jylhä-Ollila, S. (2017). Orchestrating Innovation Ecosystems: A Qualitative Analysis of Ecosystem Positioning Strategies. *Technology Innovation Management Review, 7*(3).

Van Alstyne, M. W., Parker, G. G., & Choudary, S. P. (2016). Pipelines, platforms, and the new rules of strategy. *Harvard business review, 94*(4), 54-62.

van den Besselaar, P., Hemlin, S., & van der Weijden, I. (2012). Collaboration and Competition in Research. *High Educ Policy, 25*(3), 263-266.

van der Duin, P., Heger, T., & Schlesinger, M. D. (2014). Toward networked foresight? Exploring the use of futures research in innovation networks. *Futures, 59*(0), 62-78. Retrieved from http://www.sciencedirect.com/science/article/pii/S0016328714000111

van der Zee, J. T. M. e., & Strikwerda, H. e. (1999). *Changing Business Designs for the 21st Century - How to Realize Aspirational Business Strategies* (Vol. 2). Amsterdam: Addisson Wesley Longman.

Velu, C., Barrett, M., Kohli, R., & Salge, T. O. (2013). Thriving in Open Innovation Ecosystems: Towards a Collaborative Market Orientation.

Visnjic, I., & Neely, A. (2012). Business model Innovation of Complex Service Providers- A Quest for Fit.

Vukojević, B. (2016). Creswell JW: Research design: Qualitative, quantitative, and mixed methods approaches, London: Sage publications, 2009. *Politeia, 6*(12), 191-194.

Vuori, E., & Peltoniemi, M. (2004). *Business ecosystem as the new approach to complex adaptive business environments.* Paper presented at the Proceedings of eBusiness research forum (pp. 267-281).doi:DOI

Warwick, K. (2013, 25 April 2013). *Industrial Policy: Emerging Issues and New Trends*.

Wei, W., Zhu, W., & Lin, G. (2007). Business Models, Symbionts and Business Ecosystem: A Case Study from E-commerce Industry in China.

Weil, H. B., Sabhlok, V. P., & Cooney, C. L. (2014). The dynamics of innovation ecosystems: A case study of the US biofuel market. *Energy Strategy Reviews, 3* 88-99. Retrieved from http://www.sciencedirect.com/science/article/pii/S2211467X14000297

Weiller, C., & Neely, A. (2013). *Business Model Design in Ecosystem Context*. University of Cambridge.

Weissenberger-Eibl, M. A., Almeida, A., & Seus, F. (2019). A Systems Thinking Approach to Corporate Strategy Development. *Systems, 7*(1), 16. Retrieved from https://www.mdpi.com/2079-8954/7/1/16

Wesselius, J., van den Beukel, J. W., Pasman, W., & Rutgers, J. (2007). Life Cycle Cohesion: Roadmap-Based Software Architecting for Optimal Software Evolution.

Whitley, R. (1994). Societies, Firms and Markets: The Social Structuring of Business Systems. In R. Whitley (Ed.), *The changing Eupean Firm*. London: Sage Publications.

Willyard, C. H., & McClees, C. W. (1987). Motorola's Technology Roadmap Process. *Research Management, 30*(5), 13-19. doi:10.1080/00345334.1987.11757057

Wilson, E. O. (1992). *The Diversity of Life*: W. W. Norton.

Wulf, A., & Butel, L. (2016). *Knowledge Sharing and Innovative Corporate Strategies in Collaborative Relationships: The Potential of Open Strategy in Business Ecosystems*.

Wyss Institute. (2011). Enabling Technology Platforms. Retrieved from http://wyss.harvard.edu/viewpage/enabling-technology-platforms/enabling-technology-platforms

Yan, J., Kobayashi, T., & Nakamori, Y. (2005). Study on Roadmapping Process with Integration Methods for Supporting Scientific Research.

Yin, R. (2003). Case Study Research: Design and Methods (rd edition): London.

Yin, R. K. (2009). *Case Study Research: Design and Methods* (Vol. 5). California: Sage Publications.

Yin, R. K. (2011). *Applications of case study research*: sage.

Ying, C., Kreulen, J., Campbell, M., & Abrams, C. (2011, March 29 2011-April 2 2011). *Analytics Ecosystem Transformation: A Force for Business Model Innovation.* Paper presented at the SRII Global Conference (SRII), 2011 Annual (pp. 11-20).doi:DOI

Youngblood, M. D. (2000). Winning cultures for the new economy. *Strategy & Leadership, 28*(6), 4-9. doi:10.1108/10878570010380002

Zahra, S. A., & Nambisan, S. (2012). Entrepreneurship and strategic thinking in business ecosystems. *Business Horizons, 55*(3), 219-229. Retrieved from http://www.sciencedirect.com/science/article/pii/S0007681311001881

Zhang Xiaoren, D. L., Chen Xiangdong. (2014). Interaction of Open Innovation and Business Ecosystem (pp. 51-64).

Zimmer, L. (2006). Qualitative meta-synthesis: a question of dialoguing with texts. *Journal of Advanced Nursing, 53*(3), 311-318. doi:10.1111/j.1365-2648.2006.03721.x

Zott, C., & Amit, R. (2008). The fit between product market strategy and business model: implications for firm performance. *Strategic Management Journal, 29*(1), 1-26. doi:10.1002/smj.642

Zott, C., & Amit, R. (2013). The business model: A theoretically anchored robust construct for strategic analysis. *Strategic Organization, 11*(4), 403-411. doi:10.1177/1476127013510466

APPENDIX A – KANBAN ASTRA DETAILED PROCESS (EXAMPLE)

01 – Before the interview	02 – During the interview	03 – After the interview	04 – During workshop 1	05 – After workshop 1	06 – During workshop 2	07 – After workshop 2	08 - Done
1a. Understand the company profile (current business models, products, services and customers)	2a. Ensure that the interviewee (focal point) has signed the informed-consent form and whether he/she has questions about it before starting the interview	3a. Checklist to assess the quality of the information gathered during the interview (read checklist in the comments)	4a. Ensure that all workshop participants have signed the informed-consent form and whether anyone has questions about it before starting the activity	5a. Create first version of the report (to be validated during workshop 2)	6a. Present the draft of the company's ecosystem map and inquire participants about: (i) missing information, (ii) missing links, (iii) missing players and (iv) possible strategies	7a. Send an email thanking everyone for the commitment to the activity	8a.
1b. Send the ethics term (Informed consent form) for the interviewee's signature	2b. Briefly present the project, its benefits and the expected deliverables from the application of the AStra tool	3b. Send a summary report of the interview to all involved people, requesting for confirmation of what was agreed or corrections, if necessary (depending on the assessment performed in 3a)	4b. Briefly present the project, its benefits and the expected deliverables from the application of the AStra tool (i.e. repeat presentation performed in 2b for the new participants)	5b. Create draft version of the IE map, based on the information shared during W1. This map will animate the discussion during W2	6b. Present an overview of the first version of the report. Perform corrections whenever needed	7b. Submit questions for clarification if necessary	
1c. Send a brief description of the project and its benefits	2c. Identify company's innovation needs (context for the application of the tool)	3c. Send the ethics term (Informed consent form) for signature from all workshop participants.	4c. Present an Innovation Ecosystem Case - NIKE (toolkit structure + strategies)	5c. Contact the focal point for clarifications and conduct interviews if necessary	6c. Ensure the collection of the "Dialogue Strategizing" (see "building blocks" on p.6 of the facilitator's guide)	7c. Conduct interviews if necessary	

01 – Before the interview	02 – During the interview	03 – After the interview	04 – During workshop 1	05 – After workshop 1	06 – During workshop 2	07 – After workshop 2	08 - Done
1d. Send a mini biography of AStra facilitators and other people involved	2d. Identify which service or product will be assessed in the context of the IE	3d. Send a reminder email about two days before the workshop, informing the schedule of the event	4d. Validate previously collected information: (business model + products + services + customers)	5d. Send a reminder email about two days before the workshop, informing the event schedule	6d. Apply the "Astra Post-Mortem Survey" (self- and tool assessment)	7d. Finalize the report with AStra team (review and approval)	
	2e. Verify the validity of all information collected about the company before the interview (business models, products, services and customers)		4e. Ensure the collection of the "Dialogue Strategizing" (see "building blocks" on p.6 of the facilitator's guide)			7e. Send the final report to the company's focal point	
	2f. Identify, define and guarantee the availability of the resources needed to work						

APPENDIX B – OPEN BUSINESS MODELS INVENTORY (ASTRA ARTIFACT)

What business models require the sharing of company capabilities in your ecosystem so that the value proposition is made effective to the customer? This artifact answers these questions by identifying the business models that require this collaboration among the players in the innovation ecosystem.

Business models with embed or shared capabilities that benefits value stream in an IE.

St. Gallen reference (Gassmann et al., 2014)	Business Model Name	St. Gallen reference (Gassmann et al., 2014)	Business Model Name
2	Affiliation	26	Licencing
4	Auction	27	Lock-in*
5	Barter	28	Long tail
9	Crowdsourcing	29	Make More of it
11	Digitization	33	Open Source
16	Fractional Ownership	34	Orchestrator
17	Franchising	37	Peer to Peer
18	Freemium	39	Razor and Blade*
19	From push to pull	40	Rent Instead of Buy*
20	Hidden Revenue	41	Revenue Sharing
22	Ingredient Branding	47	Solution Provider
23	Integrator	52	Two-side Market**
24	Layer Player	54	User Design
25	Leverage Customer Data	55	White Label

The concepts, the number (column St. Gallen reference) and examples for these open business models are referenced in the article “The St. Gallen Business Model Navigator” by O. Gassmann, K. Frankenberger and M. Csik.

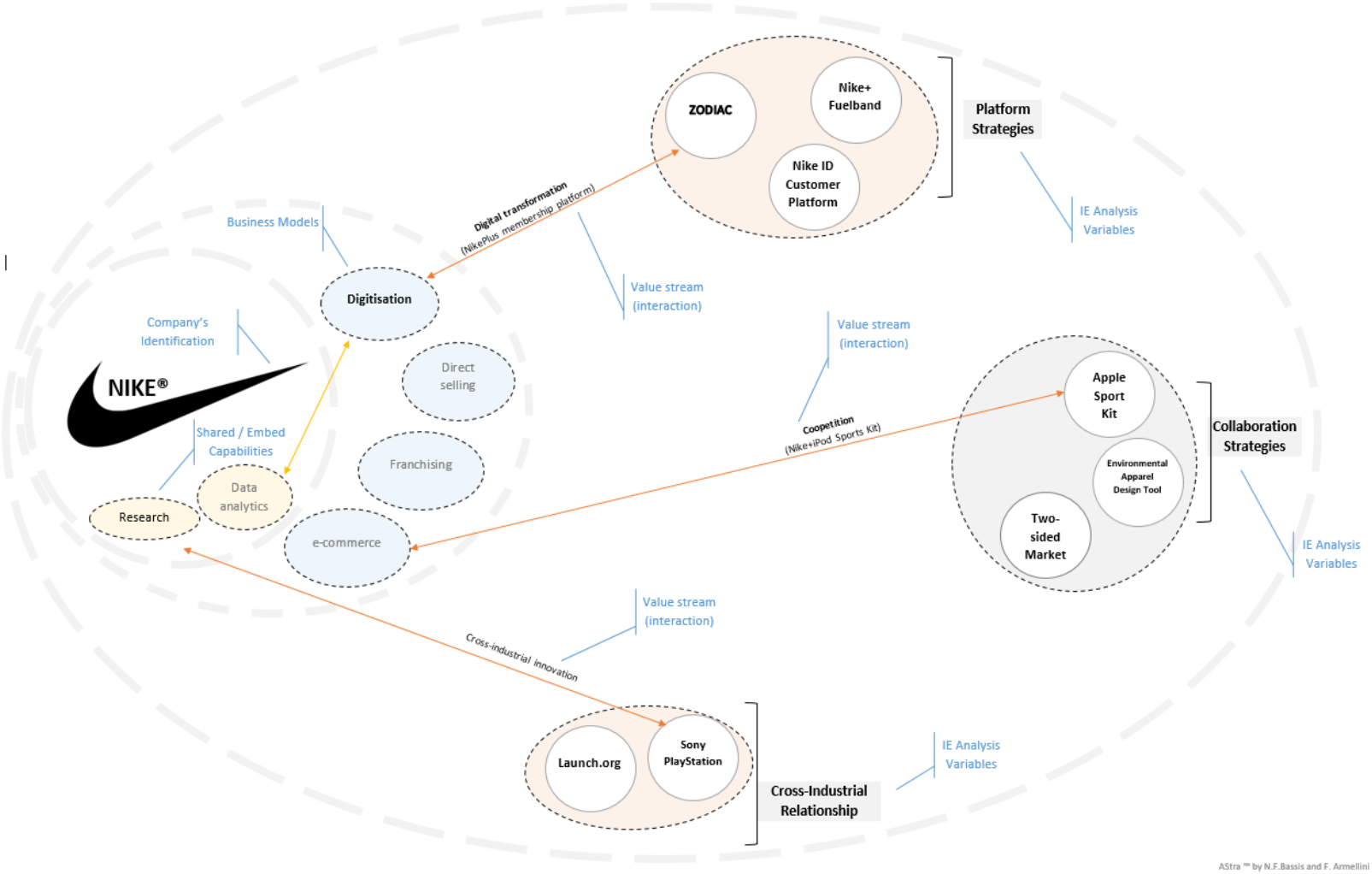
* These models are not open, but it would be considerate important to Innovation Ecosystem Analysis because they are Platform Based.

APPENDIX C – INNOVATION ECOSYSTEM ACTORS TAXONOMY (ASTRA ARTIFACT)

The "Innovation Ecosystem Actors" serves as a taxonomy (AStra artifact) for the analysis of the value stream within the innovation ecosystem. Five different segments of actors have been proposed but certainly do not represent all the possibilities exhaustively. At the same time, this classification may change according to the context of analysis of the innovation ecosystem. Actors can have multiple roles in the same ecosystem. Finally, this taxonomy should be constantly reviewed and made as support of the AStra toolkit.

<table>
<tr><th colspan="2">Innovation Ecosystem Actors Taxonomy – IEAT Taxonomy (AStra artifact)</th></tr>
<tr><td>Investors/Boosters:
Incubators
Accelerators
Angel investors
Venture capitalists
Private equity firms
Professionals
Start-ups
Private companies
Multinational enterprises (MNEs)
Individuals (Friends, Family)
Philanthropists</td><td>Knowledge providers/Innovators:
Higher Education (Universities, Technological Institutes)
Foundations
Research institutions
Scientists
Domain Experts
Military research bodies
Inventor
Entrepreneur
Intrapreneur
Co-creators (Customers)
Competitors
Technology providers
Technology transfer agencies</td></tr>
<tr><td>Promoters:
Influencers (earlier adopters, Professional experts, testers)
Communities (senior users, local or regional or thematic communities)
Virtual communities (open source platform, user platform)
Government
Lobbyists
Development agencies
Social networks
Professional education and training
Consortium
Clusters (Industrial districts, sectorial associations, horizontal or vertical clusters, Parks)
Conferences (regular events in thematic subject)</td><td>Regulatory organizations in:
Intellectual property entities
Product market regulatory organizations (Trade organizations)
Standards and certification entities
Contract enforcement organisations
Environmental and safety regulations entities</td></tr>
<tr><td colspan="2">Supporters:
Social organisations
NGO/Civil society
PPP</td></tr>
</table>

APPENDIX D – REFERENCE CASE (INITIAL DRAFT)



APPENDIX E – TRIGGER QUESTIONS OR INTERVIEW GUIDE (ASTRA ARTIFACT)

These trigger questions were developed to assist the AStra™ tool facilitator during the first interview and two workshops. This is a set of questions that should be applied in a way adapted to the reality of the company that use the tool. Other questions can be added to facilitate the analysis of the value of the ecosystem of innovation in context.

First Interview

Among your main products or services, which one will be chosen for this assessment?

Who is the customer what problem should be solved?

What is the value proposition for the end customer?

What are your main internal capabilities (internal processes) that generate value delivered to the customer?

Other questions related to the Business Model could be added.

Workshop 1

Key Questions (TOP 3/Relevant factors – Reviewed after simulation. See AStra Facilitator Guide):

Among the three main products or services, which one will be chosen for this workshop?

Regarding the product or service chosen, which are the three main competitors?

Among the top three competing products or services what are your top three strengths and weaknesses?

In the context of technological innovation what are the three main market trends and the three main customer's needs?

In terms of internal technological innovation what are the three main initiatives linked to the product or service prioritized?

In terms of internal technological innovation what are the three main projects linked to the product or service prioritized?

Who are the actors who produce / manufacture your product? (identify the main components)

What potential actors could be a source of collaboration in improving or innovating your product?

Workshop 2

Who are the actors in the innovation ecosystem and what is their role? (validation)

Are there any new competitors entering the market? What would be their main strength in relation to the product /service?

What are the three main features / functionalities that you would prioritize for an immediate future?

What would be your new initiatives for this product from the ecosystem view?

What would be your new projects for this product from the ecosystem view?

Which other actors would be the potential target of collaboration for gaining competitiveness? What are the roles of these actors?

What are the advantages for the key actors in the current and in a future innovation ecosystem?

What are the disadvantages for the actor in the current and in a future innovation ecosystem?

What could be the future value streams?

What are the compelling business models for every player in the system?

Can the set of ecosystem actors create enough value to work together?