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# Modeling a successful innovation ecosystem toward a sustainable community: The I-Reef (a review study)

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## Abstract

So far, numerous studies have exhibited Silicon Valley and other thriving innovation ecosystems by distinguishing special characteristics in which their survival rely on sustaining activities that convert them to specific regions. These regions provide ready-made grounds for networking to be innovative. Meantime, it is struggling for innovations to be transformed into measurable economic results if players encounter a weak network of collaborative relationships in the ecosystem. Besides, flowing back the created value in the same region could be another problem with the actual innovation ecosystems to be utilized by all players created this. It is interesting that successful innovation ecosystems share many characteristics with coral reefs in which the process of economic growth and the renewal of an evergreen region is credible in specific collaborative relationships. Hence, the I-Reef model suggests a particular ecosystem where All-Win contribution relationships of the regional innovation networks return the results into the whole region.

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*Keywords:* Innovation ecosystems; Sustainability; Win-All collaboration; Innovation Reef

## 1. Introduction

Many studies have been carried out on commercialization achievements and its successful process in innovation ecosystems. The results have released that there are two main problems with the actual innovation ecosystem in some regions:

- First, the weak network of collaborative or mutualistic relationships for Successful and healthy commercialization of products which would be more challenging for players in an infrequent and not equally distributed sources.

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## Nomenclature

I-Reef	Innovation Reef
SCIE	Sustainable and Confederated Ecosystem

- Second, the created value from innovations is not purposefully flown back into the same region to be used by players created it [1].

In relation to this, facilitating technology commercialization in order to continue the growth of the innovation ecosystem requires planning, strategy, and community. Studying the best practices is required at the interface of knowledge and practice, and in return of practical wisdom to science, to light the successful key activities and qualities of a culture or a society. Despite the acknowledgment of the co-creation role within successful cultures of innovation ecosystems and entrepreneurship development, the techniques that can provide, firstly, an environment with collaborative networks within a mutually profitable framework and, secondly, how to cycle back the value generated from innovations to the entire region are still open challenges.

Thereby, we advanced with the proposal of a holistic model to characterize an I-Reef, as a tool to identify its key attributes, support its specifications and for coping aforementioned challenges in order to compose a more confederated and sustainable innovation ecosystem. Given objectives, the research gathered the best practices through some advanced innovation societies, exploring an exhaustive attributes portfolio that helps to simplify the creation of the I-Reef Model and its essential infrastructures.

Primary, the study, therefore, was conducted an extensive literature review on the evolution of innovation systems toward the I-Reef ecosystem with regard to identifying its attributes. Then, the study has utilized the “best practice”, the successful Austin ecosystem, which helps to simplify the creation of the I-Reef Model and its essential infrastructures.

## 2. State of the art

So far, numerous studies have exhibited remarkable qualities of Silicon Valley and other similar successful open innovation ecosystems. These identified characteristics reflect good practices in the management of innovations, including those ones characterizing successful regional innovation ecosystems [2]. The development of networks, business clusters, and relationships in innovation regions is conducted to offer ready-made ground for networking and the realization of the potential of intellectual and social capital. However, some regions do not have access to an adequate spreading of resources for providing mutually beneficial cooperation and build a supportive ecosystem for all players. Moreover, co-creation results for players and socio-economic innovation regions that host it [3], has caused the collective effort of these regions to effectively concentrate on collaborative value creation and retention to empower the ecosystem. Meanwhile, in some regions, the value generated from technology innovations not flow back into the region [4–6]. Indeed, the effects of this co-creation to return and not flow away from where the value is created, have rarely been studied.

In Current models of innovation ecosystems, a clear roadmap to visualize the best manner of bringing together the right types of people to accelerate startup and new product success is still lacking [7]. To provide an evergreen source for economic growth and renewal, the coral reef model was developed through idea-to-product improvement within the historical trend of open innovation, [7,8]. The I-Reef framework supports successful innovative approaches like RIS3 (Research and Innovation Strategies for Smart Specialization) within regional and national ecosystems and Triple Helix generations, adapted from the technopolis wheel [9] in which describe how the multiple entities and influencers interact mutually to create a thriving entrepreneurial ecosystem.

The I-Reef model, based on a metaphor of the biological abundance and diversity, found in a coral reef system, creates a condensed ecosystem with providing centralized resources to facilitate converting a normal (regular) environment, sometimes with an inadequate spreading of nutrients toward innovation into an environment with all kind of resources, the collaborative network and mutually beneficial currency exchanges and ultimately spreading wealth cycled into the same region.

The prime healthy I-Reef has been observed in Austin’s entrepreneurial ecosystem, successfully disseminated in other regions [10], in which the triple helix support has helped the needs of other players with lack of access

to the resources, resulting in regions collective synergies for vibrant economic growth [7,11]. Our study proposes the newly developed model as a holistic model to characterizing a tool that specifies how to establish it from an attributes portfolio in which the participation results in a Win-All collaborative environment.

### 3. Discussion and results

Story of selecting Austin as an “entrepreneurial city”, in one hand, has been begun from a trend of being a normal innovation region to become Austin’s genesis entrepreneurial ecosystem from the 1990s. The secret of this novel evolution has been disclosed from this cutting edge study concluded in the following [12]:

- First, this entrepreneurial city is based on the well-cultivated and nutrient foundation that focused on some principles like encouraging entrepreneurship, rousing the cooperation between various kind of new and established entities, emphasizing the returning the value created to the region.
- Second, 3 effective factors have been additionally advanced Austin as a thriving entrepreneurial city considered also as consequence phases:

Providing the “capacity building and development of entrepreneurship” at the University of Texas at Austin (UT). This is facilitated by first, the competitive ability of UT’s Computer Science Department for attracting large high-tech companies to Austin in the hardware and software industries. Second, realizing a successfully developed Triple Helix approach with UT-The Greater Austin Chamber of Commerce (GACC)-The state and city governments-The private sector Collaboration which leads to two accomplished bid in large computer and semiconductor R&D consortia into Austin like MCC (Microelectronics and Computer Technology Corporation) and Sematech (Semiconductor Manufacturing Technology). Third and finally UT’s spinoffs with high capability to become a multinational company as well as IC2 Institute’s ATI (1989-present) Spinoffs as the byproduct from the Austin Technology Incubator (ATI) and founded within the IC2 Institute. These created spinoffs drive to usefully transformation of the generated knowledge from R&D structures into effective solutions to firms.

A successful attraction of large high-tech companies. The slight tendency of moving big companies like IBM and Motorola to Austin had a steady incline between the 60 s till 70 s. While this attraction changed to a dramatic increase, many from Silicon Valley, stimulated by preparing a ready-made ground for entrepreneurship due to the Austin motivations for expansion and the high-tech clusters reaching critical mass after the arrival of MCC and Sematech in 2000.

Austin entrepreneurial ecosystem has benefited from both corporate spinoffs and entrepreneurial spawning. It has conducted to a pioneer foundation of training the future technology-oriented entrepreneurs. To illustrate, local entrepreneurs gained experiences with the chance of working in large companies like IBM and encouraged to start their own business. Accordingly, it has resulted in spawning a dramatic creation of start-ups just, at least 29, between 1990 and 2013.

Selecting Austin as the number one entrepreneurial city in the United States in two consecutive years owes to creating a nutrient and responsible networked region for innovation and entrepreneurship. Austin, in fact, has become a community of entrepreneurs in which small actors with little previous experience or enough funding would be able to work with large corporations or fast-growing start-ups. This has similar advantages for large companies needed more innovations with shaping strong ties accompanied by such an entrepreneurial community. As an illustration, according to Elsie Echeverri-Carroll [12], “almost all of the start-ups founded in Austin have been successful as indicated by the fact that 62 are still active companies and 36 were acquired”.

The growth cemented Austin toward being number one entrepreneurial city, has incentivized many large corporations to continue their activity in the city. It has resulted in the expansion in physical and workforce of these large high-tech firms. It has a consequence to lay the foundations for cycling the generated value, financial or nonfinancial, to Austin.

On the other hand, it is interesting that our study based on the related prior studies about the successful technology transfer into innovation ecosystems exhibit some remarkable similarities in function with coral reefs. Simple observation of marine environments shows in regions with special environmental conditions, the coral reef separates near-shore and deep-water environments and provides a complex ecosystem. It involves aggregated dilute resources and a nexus point for the development of mutualistic interactions among players to make a very different ecosystem to grow. The physical reef structure, inhabitants and relationships will serve as the physical model for

the conceptual I-Reef that can assist in realizing the commercial benefit from innovations [13]. Both successful innovation ecosystems and a coral reef have a fragile structure that requires specific conditions to thrive. The survival and growth of a coral reef depend on a specific light, temperatures and salinity ranges, similarly, commercialization can yield value to the I-Reef ecosystem with the backing of the Environmental Factors (EFs) and The public policies (PP) resulting to the cultivation of the proper environment to support the economic growth. Thus, given an in-depth and accumulated vision to the studies result toward advanced innovation ecosystems and thriving Austin city, distinctive characteristics of such entrepreneurial genesis communities have been demonstrated in Table 1.

**Table 1.** Distinctive characteristics of I-Reef ecosystem.

Row	Factor	Item	Reference (Eclectic selection)	
1	The diversity of Players (DOP)	DOP <sub>1</sub>	A density of diverse players (small and big entities like anchors, mentors, and others) • Gregory P. Pogue, & et al. (2010) • Yun, Jeong, and Park [14] • Smilor [9] • Bjercke [15]	
		IAP <sub>1</sub>	Triple Helix approach • Carayannis, Barth, and Campbell [16] • Barth, T. D. (2011)	
	Interaction Approaches between Players (IAP)	IAP <sub>2</sub>	Mutualistic relationships (Win-all oriented) • NTT DATA. (2015)	
		IAP <sub>3</sub>	Flourishing COPs • Pyrko, Dörfler, and Eden [17] • Hippel [18]	
		Distinguishing Characteristics (DC) in comparison with other regions	DC <sub>1</sub>	Sustainable value-flow • Gregory P. Pogue, & et al. (2010) • Pogue, G., & et al. (2016)
	DC <sub>2</sub>		Booster environment (open Innovation capabilities) • Annette Böhmer. (2015) • Kenney, M. (2000)	
	DC <sub>3</sub>		Aggregation and accessibility of resources • Gregory P. Pogue, & et al. (2010) • Pogue, G., & et al. (2016)	
	DC <sub>4</sub>		First adoption of innovative strategies and policy instruments • Gregory P. Pogue, & et al. (2010)	
	2	Environmental Fundamental Structure (EFS) (To be Prone to building a complex environment)	EF <sub>1</sub>	Material and services resources • Polese et al. [19] • Code [20]
			EF <sub>2</sub>	Culture and social aspects • Khosla, V. (2018) • Bjercke [15]
3	Public policies (PP)	PP <sub>1</sub>	Regional strategies and policies • Maillat, D. (1995) • Schrempf, B. & et al. (2013)	
		PP <sub>2</sub>	Diversification of policy instruments at local, regional and state levels • Arthur B. Markman & et al. (2016) • Pogue, G., & et al. (2016) • Gregory P. Pogue, & et al. (2010)	
		PP <sub>3</sub>	Influential government support with encouraging policies and strategies • Arthur B. Markman & et al. (2016) • Pogue, G., & et al. (2016) • Gregory P. Pogue, & et al. (2010)	

#### 4. Discussion and conclusion

Concerning the transformation of technology innovations into measurable economic achievements, our study has been helped by cutting-edge practices like Austin entrepreneurial city toward exploring the distinguishing attributes of these successful innovation ecosystems. Main identified characteristics of such thriving innovation ecosystems remind a similarity with coral reefs function. The research has shaped a schematic pre-model to create more comprehensibility of an I-Reef model, Fig. 1.

An I-Reef structure consists of 3 main component groups: 1—Diversity of players (DOP) and interaction approaches between them 2—Environmental Factors (EF) and 3—Effective Factors on an I-Reef performance, The

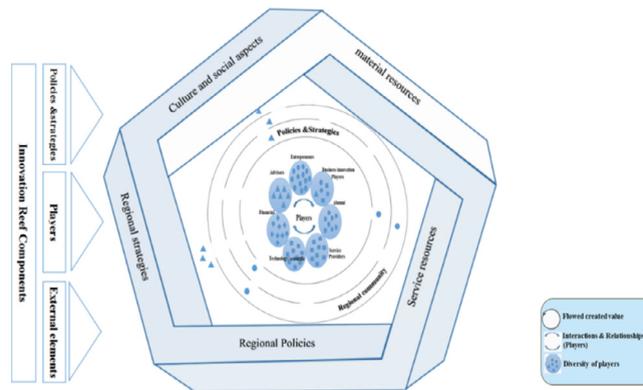


Fig. 1. The I-Reef pre-model: Current study, 2019.

public policies (PP) as the catalyzer [21] provide specific conditions for the establishment and enabling of the I-Reef ecosystem. This special ecosystem assumes diverse roles for players likewise to their peer-partners, simultaneous or in a different time and position into the ecosystem. The various functional groups of stakeholders in the I-Reef framework causes the innovation promotes through openly mutualistic exchanges and collaboration.

The architected nexus of engagement framework makes a particular ecosystem where the mutualistic relationships could be Communities of Practices (COPs) of the regional innovation networks to create an “acquisition, applying and retaining value chain” with, and for, all co-creators to return the results into the whole region. The research, as an ongoing study, based on an in-depth study has made a function to set up an optimizer tool aiming to assist in constructing a sustainable and confederated ecosystem (SCIE) through appraising and development of innovative ecosystem performance.

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## References

- [1] Development R, Articles J. IC 2 Institute Research, no. January 2015, pp. 2–6, 2016.
- [2] Asefi S, Resende DN, Amorim MP. Establishing an Innovation Reef - an Holistic Model Towards Exploring its Attributes, in: 7th Iberian conference on entrepreneurship 8 and 9 June esposende - PDF, 2017.
- [3] Ferretti M, Parmentola A. The Creation of Local Innovation Systems in Emerging Countries. 2015.
- [4] Adner R, Kapoor R. Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. *Strateg Manag J* 2010;31(3):306–33.
- [5] Lee SM, Olson DL, Trimi S. Co-innovation: Convergogenomics, collaboration, and co-creation for organizational values. *Manag Decis* 2012.
- [6] Radziwon A, Bogers M, Bilberg A. Creating and capturing value in a regional innovation ecosystem: a study of how manufacturing SMEs develop collaborative solutions. *Int J Technol Manag* 2017.
- [7] Thomson K, Lorenzini F, Markman AB, Pogue GP, French R. Building an innovation coral reef. In: *Open innovation*. Oxford University Press; 2016, p. 203–24.
- [8] Chesbrough H. *Open Innovation*. 2006.
- [9] Smilor RW, Gibson DV, Kozmetsky G. Creating the technopolis: High-technology development in Austin, Texas. *J Bus Ventur* 1989;4(1):49–67.
- [10] Pogue G. *Blog Archives - David F. Chang*, 2014.
- [11] Peterson CM, Robert A. *Newsletter of the IC<sup>2</sup> Institute*, 2016.
- [12] Echeverri-Carroll Elsie. 2017-austin-entrepreneurial-genesis-infographic.pdf. 2017.
- [13] Pogue GP, Lorenzini F, Keela T. *Technology Transfer and the Innovation Reef*. 2015.
- [14] Yun JHJ, Jeong ES, Park JS. *Network analysis of open innovation*. *Sustain*. 2016;8(8):1–21.
- [15] Bjercke BP. *Business Incubators as a resource provider*, 2015.
- [16] Carayannis EG, Barth TD, Campbell DF. *The Quintuple Helix innovation model: global warming as a challenge and driver for innovation*, 2012.

- [17] Pyrko I, Dörfler V, Eden C. Thinking together: What makes communities of practice work?. *Hum Relat* 2017;70(4):389–409.
- [18] von Hippel E. Democratizing innovation, The evolving phenomenon of user innovation, 55 (1) (2005) 63–78.
- [19] Polese F, Botti A, Grimaldi M, Monda A, Vesci M. The effect of network position on the performance of open innovation in service systems. *Sustain* 2018;10(1).
- [20] Code L. Science in business administration the effect of network position on the performance of open innovation in service systems - econometric analysis based on social network theory Master Thesis, Graduate School of Seoul National University; 2014.
- [21] Asefi S, Resende DN, Amorim MP. CENTERIS 2018 Conference. 2018.