Designing a Maturity Model for Software Startup Ecosystems

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Abstract. Resulting from the technological revolution from the last decades, we observed many software startup ecosystems emerging around the globe. Having tech entrepreneurs as their main agents, some ecosystems exist for more than 50 years, while others are newly born. This difference in terms of evolution and maturity makes the task of comparing different tech hubs a challenge. Moreover, nascent ecosystems need a clear vision of how to develop their community to evolve towards a fruitful and sustainable ecosystem. This paper proposes a maturity model for software startup ecosystems based on a multiple case study of two existing ecosystems. By determining the maturity level for each ecosystem, it is possible not only to compare different realities, but mainly to identify gaps and propose customized practical actions that can lead to real improvements in the existing ecosystems, taking it to the next level of development, promoting innovation.

Keywords: Startup Ecosystems, Maturity Model, Entrepreneurship

1 Introduction

In the last two decades, we observed the rising and maturation of many software startup ecosystems around the world. The Global Entrepreneurship Monitor shows that human capital and social capital co-evolve [21, 23]. Given the existence of hundreds of technological clusters in different countries, it is difficult to identify what is the level of development of each ecosystem. This paper proposes a methodology to measure each Ecosystem's level of maturity with respect to multiple factors. By determining the maturity level for each ecosystem, it is possible not only to compare different realities, but mainly propose practical actions that can lead to real improvements in the existing ecosystems.

As our previous research has identified [16, 17], software startup ecosystems are a complex social structure where entrepreneurs and their tech ventures are the main actors. Some of these high tech ventures will evolve to high-growth

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firms, which make a disproportionate impact to economic growth [19]. By identifying opportunities in the market, an entrepreneur creates a startup. Startups face multiple challenges to discover its market fit [13] and be successful. For that, the entrepreneur gets support from family, friends, and other personal connections, who are part of a society and culture that influence the entrepreneur's behavior. Demographics characteristics such as language, race, religion, and gender influence the culture and creates opportunities and barriers to the entrepreneur. The geopolitical status also influences the culture and creates opportunities and barriers for the startup. Universities and research centers provide knowledge in technologies that enable the startup, by preparing the entrepreneur and providing networking possibilities. Universities and research centers also guide entrepreneurs on the technology transfer process [3]. Successful, experienced entrepreneurs serve as mentors to novices. Universities and established companies run incubators and accelerators that train and instrument the startup with methodologies such as agile methods [1], lean startup [22], customer development [5], and disciplined entrepreneurship [2]. Eventually, established companies buy, compete, or collaborate with the startup. Private funding bodies like angels and venture capitalists mentor and invest on startups, which can also get financial resources from governmental programs through R&D funding agencies or tax incentives. The existing legal frame (labor laws, tax laws, IP, patents, and its associated bureaucracy) influences costs and frames the startup business model.

2 Related Work

Startup ecosystems cannot be analyzed as static entities. Similar to biological ecosystems, they behave like living organisms, changing over time. Some changes are planned or somehow controlled, while others are results of unexpected forces acting within and outside the ecosystem. Although startup ecosystems are a novel object of study, we already have enough examples to state that these ecosystems pass through the following phases: **Nascent**, **Evolving**, **Mature**, and **Self-sustainable**. There are also examples of ecosystem **degradation** or **illness**, like what has been reported in Atlanta [7].

Frenkel and Maital propose a methodology for mapping national innovation ecosystems [12]. The methodology is based on a workshop with experts on the ecosystem. They identify anchors and processes that characterize that particular ecosystem, leading to a visual innovation ecosystem map. Their methodology was applied to several countries and it resembles, in some aspects, the methods we use in this research. The major difference is that our work extends their approach by also including meetings and interviews with ecosystem players, while Frenkel and Maital's methodology is based on a single workshop with experts. Another difference is that our study focus only on software startups.

The World Economic Forum mapped eight pillars of entrepreneurial ecosystems [11], namely (1) accessible markets, (2) human capital workforce, (3) funding and finance, (4) mentors and advisors support system, (5) regulatory framework and infrastructure, (6) education and training, (7) major universities as

catalysts, and (8) cultural support. All these eight elements are present in our proposed maturity model and conceptual framework.

Lemos mapped entrepreneurship ecosystems based on the perspective of a research university [18]. In another approach trying to understand ecosystems, Brad Feld presents the "Boulder Hypothesis" [10] with four essential characteristics in a successful startup community: (1) it must be led by entrepreneurs and not by other important players such as government, universities, service providers, big companies, etc., which Feld call feeders; (2) the leaders (entrepreneurs) must have a long term commitment with the community (at least 20 years); (3) it has to be inclusive, which means that everybody who wants to participate must be welcome; and (4) it must have high quality events to engage people, specially acceleration programs and mentoring sessions. Less fragmented ecosystems would score higher on all 4 elements. Feld's model challenges the triple helix model (governments, universities, and industries) [6]. Recent studies show that policies with focus on bottom-up approaches are more efficient when developing startup ecosystems [24], putting the entrepreneur as the main change agent, while the traditional triple helix model tends to discard the entrepreneurs focusing only on government, university, and industry.

Changes in ecosystems are observed over time, and some differences can take years or sometimes decades to be observed. Ecosystems have a dynamic and evolutionary nature rather than a static phenomenon that can be captured by a snapshot at a given point in time [19]. The startup ecosystem report 2012 [15] proposes a ranking of the top 20 ecosystems in the technologic economy. It puts Silicon Valley as a benchmark and compare other ecosystems to it. Three years later, another report, The global startup ecosystem ranking 2015 [14], revises the 2012 version, presenting a new landscape of ecosystems, showing new technological hubs entering the ranking as well as old startup agglomerations that did not evolved enough to enter in the new top 20. The questions that arise are: what happened to those ecosystems that felt out of the ranking? What did the ecosystems that entered in the ranking performed to scale up? Being higher in the ranking means to get better? Being lower means to get worse? Could the evolution across maturity levels stages be an evidence of a virtuous cycle [4]?

3 Methodology

The maturity model proposed in this paper is based on a conceptual framework for startup ecosystems that we developed after an extensive literature review about existing ecosystems and a detailed qualitative research we performed in two existing ecosystems: Tel Aviv [16] and São Paulo [9]. Our qualitative methodology was based on two different techniques: (1) a multiple case study [25] based on more than 80 semi-structured interviews with key players (entrepreneurs, investors, educators, executives, etc.) in both ecosystems; (2) a systematic workshop / focus group that we executed in São Paulo [9].

The conceptual framework contains core elements that relate to each other. We can analyze the level of development of each core element, as well as the

quality of the relationship between them to measure some degree of maturity in each aspect. For example, there is the funding bodies core element. The development level of the funding structure inside the ecosystem is a measurement of maturity. The presence of technical talent, provided by high quality educational institutions, or access to educational resources are other examples of factors to measure the ecosystem maturity. Thus, we propose, for each core element, a scale to evaluate its state. The scale contains three levels of development: **L1**, **L2**, and **L3**. We then propose a metric to classify ecosystems for each core element maturity, described in Table 1. This table was generated after a series of iterations with specialists and confirmation of what they considered the right measurement of **L1**, **L2** and **L3** in each aspect. The full explanation of each factor scale and measuarements can be found in the Startup Ecosystem Maturity Model Technical Report [8].

Table 1. Ecosystem Maturity Factor Classification

Factor	L1	L2	L3
* Exit strategies	0	1	$>= 2$
* Global market	$< 10\%$	$10 - 50\%$	$> 50\%$
Entrepreneurship in universities	$< 2\%$	$2 - 10\%$	$> 10\%$
* Number of startups	< 500k	$500 - 3$k	> 3k
* Access to funding in USD / year	200M	200M-1B	> 1B
Access to funding in # of deals / year	200	200-1000	1000
Mentoring quality	$< 10\%$	10-%50%	$> 50\%$
Bureaucracy	$> 40\%$	$10 - 40\%$	$< 10\%$
Tax burden	$> 50\%$	$30 - 50\%$	$< 30\%$
Incubators / tech parks	2	$2 - 10$	> 10
Accelerators quality	$< 10\%$	$10 - 50\%$ success	$> 50\%$ success
* High-tech companies presence	< 10	$10 - 50$	> 50
Established companies influence	< 20	$20 - 80$	> 80
* Human capital quality	> 20th	$15 - 20$th	< 15th
* Culture values for entrepreneurship	< 0.5	$0.5 - 0.75$	> 0.75
Technology transfer processes	< 4.0	$4.0 - 5.0 > 5.0$?	
Methodologies knowledge	$< 20\%$	$20 - 60\%$	$> 60\%$
Specialized media players	< 3	3-5	> 5
* Ecosystem data and research	not available	partially available	fully available
* Ecosystem generations	0	1	2

4 Results

Some factors in the ecosystem comparison table are crucial to be considered when an ecosystem has reached a certain level of maturity. Not achieving a specific grade in any of these factors keeps the ecosystem on a lower level of maturity.

Thus, we divided the factors in two categories: **essential** and **summing**. The summing factors are important to "upgrade" the ecosystem to the next level.

Our proposal of maturity model is divided into four levels as described below:

- **Nascent (M1)**: usually when the ecosystem is already recognized as a startup hub, with some already existing startups, a few investment deals and maybe government initiatives to stimulate or accelerate the ecosystem development, but no great output in terms of jobs generation or worldwide penetration.
- **Evolving (M2)**: ecosystems with a few successful companies, some regional impact, job generation and small local economic impact. To be in this level, the ecosystem must have all essential factors classified at least at L2, and 30% of summing factors also on L2.
- **Mature (M3)**: ecosystems with hundreds of startups, where there is a considerable amount of investing deals, existing successful startups with worldwide impact, a first generation of successful entrepreneurs who started to help the ecosystem to grow and be self-sustainable. To be in this level, the ecosystem must have all essential factors classified at least at L2, 50% of summing factors also on L2, and at least 30% of all factors on L3.
- **Self-sustainable (M4)**: ecosystems with thousand of startups and financing deals, at least a 2nd generation of entrepreneur mentors, specially angel investors, a strong network of successful entrepreneurs compromised with the long term maintenance of the ecosystem, an inclusive environment with many startups events and presence of high quality technical talent (as proposed in the Boulder Thesis by Brad Feld [10]). To be in this level, the ecosystem must have all essential factors classified as L3, and 80% of summing factors also on L3.

After generating the classification table for each factor, we filled the table with data about the ecosystems we analyzed, also using the help of two specialists in each ecosystem. The resulting Table 2 shows data collected from both the Tel Aviv and São Paulo Ecosystems.

Table 2. Startup Ecosystem Comparison Table

	Tel Aviv	São Paulo
* Essential Factors	L3 (9)	L2 (9)
Summing Factors	L2 (5), L3 (6)	L1 (8), L2 (3)
Maturity Level	Mature (M3)	Evolving (M2)

As a secondary metric, we can use the ecosystem progress within a certain level to understand how far it is from being upgraded to the next level. For example, Tel Aviv has all essential factors in L3 and 54% of the summing factors in L3, which suggests the ecosystem is almost reaching the M4 maturity level. On the other hand, São Paulo has no essential or summing factor on L3, suggesting

that the ecosystem just entered the M2 level and needs more effort to reach the next level.

5 Conclusions and Future Work

This paper proposes a novel maturity model for software startup ecosystems based on an extensive literature study as well as a multiple case study of two existing ecosystems. A conceptual framework of software startup ecosystems was created from these studies and the maturity model was validated with specialists from these ecosystems. The findings show that Tel Aviv is considered a **Mature (M3)** ecosystem, while São Paulo is **Evolving (M2)**.

The maturity model can be used to identify gaps in each ecosystem, showing a direction on which the local community should concentrate, promoting initiatives to take the ecosystem to the next level.

A missing element in the current version of the maturity model is the measurement of interconnectivity between agents within the ecosystem. Literature shows that this is a very important aspect [20] to analyze the ecosystem maturity and, thus, should be included in the evaluation criteria. Future work should investigate how to measure the quality of the entrepreneurship network and how to fit it into the whole maturity model.

As a next step in this research, we will carry out a new round of interviews in the New York ecosystem, classifying it according to the maturity model. These new findings will then be used to further adapt the model towards a refined version. We will then invite specialists from different ecosystems around the world to perform the exercise of classifying their ecosystem using this model, criticizing the criterion we proposed and helping to improve it collaboratively.

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