

Software Startup Ecosystems Evolution

The New York City Case Study

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Abstract—Startup ecosystems started to emerge in different parts of the world since the 2000s. They normally focus on specific areas and present different characteristics and dynamics. Also, each ecosystem has its own path of evolution over time. In this paper, we analyze the dynamics of these ecosystems by taking the New York case study as an example. We show what stages ecosystems pass through, the requirements for each of these phases and why it is possible for many ecosystems to evolve until reaching a self-sustainable level of maturity. This research can bring a better understanding of the evolution of software startup ecosystems and what role their actors play in this development. The results can be used as a basis for ecosystem stakeholders to reflect and act concretely on improving the maturity of their local environments.

Keywords — *entrepreneurship; startups; startup ecosystems; innovation; maturity model; New York City*

I. INTRODUCTION

Economic theory shows that startups and entrepreneurs are the prime forces in modern economic development. Disturbance of economic systems is impossible without them [1]. Besides creating new jobs and generating wealth to the society, they foster the technological innovation of industries. New venture creation is statistically linked to both job creation [2] and regional development [3]. High rates of entrepreneurial activity are strongly related with the growth of local economies. Entrepreneurial market activity is mostly a decentralized and unplanned process [4][5], in which innovative companies must interact with each other effectively to achieve success [6]; thus, technological entrepreneurs act in the context of complex entrepreneurship ecosystems that can be viewed as a new paradigm for economic policies [7].

In this work, we chose to focus on technological entrepreneurs and their software startups, companies with high-growth and scalable business models [8]. Startups usually have to pivot their strategy, especially in the first two years, until they find their product market fit [9]. A supportive startup ecosystem can help entrepreneurs during these instability periods. We define a startup ecosystem as a “limited region within 30 miles (or one hour travel) range, formed by people, their startups, and various types of supporting organizations, interacting as a complex system to create new startup companies and evolve the existing ones”.

Any healthy entrepreneurial ecosystem has direct impact on entrepreneurs' lives [10]. Several studies try to identify gaps in innovation ecosystems and propose practical actions to improve their performance. There are examples in Germany [11][12], India [3], Portugal [13] and Israel [14][15].

This paper is based on a case study of the New York City software startup ecosystem. Rather than mapping the characteristics of a specific innovation ecosystem and proposing actions and policies for that [16], the primary objective of this research was to understand the dynamics of ecosystems and explore how they evolve over time.

Based on the ecosystem maturity classification created in our previous work [17], in less than 15 years, the New York City startup ecosystem evolved from the first level of maturity (Nascent/Emergent) to the top level (Mature/Self-sustainable). It shows not only that it is possible for a particular region to develop a healthy entrepreneurial environment, but also that this development progresses through a path of multiple phases, in which each phase can be determined by different characteristics and requires specific management approaches. Moreover, this particular evolution is closely related to the moment when technology invaded mainstream businesses and traditional business centers started to become technology centers.

This paper shows how this case study [18][19] can be used to generalize a theory about startup ecosystems. Section II discusses existing literature and theory about startup ecosystems. Section III explains the methodology used to collect data and analyze the results. Section IV presents our findings. Finally, Section V states our conclusions, suggestions for future work, and the research limitations.

II. RELATED LITERATURE

The groundwork for the startup ecosystems literature was laid years before both the terms “ecosystem” and “startup” began to be broadly used and understood in the context of company creation. Dating back to the 1980s and 1990s, some scholars have studied geographic regions around the world where entrepreneurs have successfully emerged in an attempt to understand the reasons behind that success [20][21][22][23]. Others have focused on prescriptions for supportive environments for emerging businesses that feature human development and other services [24][25]. This literature made

early contributions to the idea of a context that is supportive to both entrepreneurs and their enterprises, a concept that was later fleshed out in the model of a “pipeline of entrepreneurs and enterprises” for managing a community’s portfolio of businesses [26].

In 2001, Lichtenstein and Lyons presented their “entrepreneurial development system”, an approach that focused on the development of entrepreneurial skills through a community-wide or regional coaching and support system, as the main strategy for creating wealth and economic prosperity [27].

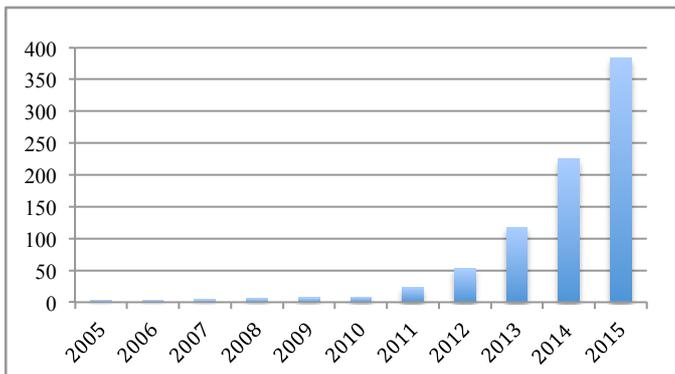


Figure 1 - Papers containing the term "startup ecosystem".
Source: Google Scholar

The term in good currency at that time was “entrepreneurial community”. Studies by both the Edward Lowe and W.K. Kellogg foundations contributed to our understanding of the elements of such a community, which included a supportive local culture; a helpful government; strong hard and soft infrastructure; a varied collection of financial resources; support for youth entrepreneurship, and broad and strong networks [28][29]. Building upon this work, Lichtenstein et al. [30] and Markley et al. [31][32], offered prescriptions for fostering entrepreneurship among civic leaders and developing entrepreneurs and their businesses in entrepreneurial communities.

Fritsch and Mueller analyze new business formation over time in different German regions, claiming that startup creation can have a positive impact on job creation only for a short period of one or two years. When the ecosystem starts to evolve, if new companies do not have the necessary support to continue their growth, or the ecosystem does not have enough density, job creation tends to slow down [33].

The term “startup ecosystem” appeared in the literature around 2005 and, according to Google Scholar, the occurrence of this term started to grow exponentially since 2010 as depicted in Figure 1. In fact, the notion of startup ecosystems emerged when technology (especially the Internet, and later, mobile systems) entered the mainstream and became a crucial aspect for innovation, transforming many traditional business centers into technology centers.

Nevertheless, very few works explore the ecosystem dynamics and evolutionary nature. To analyze them, taking a snapshot at a given point in time is not enough [34].

Ecosystems need to be evaluated in the course of years, a longer period where we can observe the process of ecosystem maturity.

The literature has many articles and books about general entrepreneurship, but very few works that focus on software startups and the ecosystems that produce them. In our previous work [35], we proposed a model to represent this maturity process. It considers 21 factors such as access to global markets, mentoring quality, accelerators quality, human capital, entrepreneurship in universities, etc. The model proposes 4 levels of maturity: **nascent** (M1), **evolving** (M2), **mature** (M3) and **self-sustainable** (M4). Since then, we evolved the model with feedback received from practitioners and researchers, especially from the Software Startups Global Research Network¹.

III. METHODOLOGY

This research was conducted in the New York City region, in a range of 15 miles from Manhattan center, in October 2015. The qualitative research method included performing 25 semi-structured interviews with NYC startup ecosystem agents among entrepreneurs (14), investors (4), scholars (4), and other supporting players (3). The interviewees were selected by snowballing [36] our network in both academia and industry. Most of the participants were more than 30 years old; the average age was 42 with standard deviation of 11. They were 17 males and 8 females in roles like CEO, COO, CTO, lawyer, professor, manager, founding partner, and writer. All interviewees had at minimum an undergraduate degree, 38% had a master’s or MBA and 13% were PhDs.

The interview protocol² was a refined version of the one used in our previous research in both Israel [37] and São Paulo [38]. The protocol was designed to answer the following research questions:

- What are the minimum requirements for a startup ecosystem to exist in its nascent stage?
- What are the requirements for a startup ecosystem to exist as a mature self-sustainable ecosystem?
- What are the stages that ecosystems pass through? Can they regress or die?
- Can people proactively interfere in the evolution of ecosystems? Is it possible to create ecosystems as evolved as, e.g., the Silicon Valley?

The objective of these interviews was not only to understand ecosystem elements, which were already mapped in our previous studies, but also to explore the dynamics of ecosystem evolution.

An extensive review of the related literature was performed since our first case study in Israel [14]. The sources for articles were: Google Scholar, recommendations from ecosystem research experts, and snowballing from references within the articles we read. The keywords used in the search were “startup

¹ <http://www.softwarestartups.org>

² Available at <http://bit.ly/ime-startups-pubs>

ecosystem” and “entrepreneurship ecosystem”. It was not a fully comprehensive systematic review, but still encompassed 248 readings, including books (45), reports (17), theses (4), and articles (182) published on conferences and academic journals on business, high-tech ventures, entrepreneurship, regional development, innovation, software, and management.

To reinforce the qualitative insights from the interviews, we explored quantitative data about startups from the Crunchbase database. Despite the fact that this database is not an official source of information about all existing startups, it is a good representation of the reality. Most relevant startups, especially those that received or want to receive investment, are listed in this database. Moreover, absolute and perfectly correct numbers are not necessary for the conclusions we present.

IV. FINDINGS

In New York City, the first high-growth technology software startups appeared in the late 1990s in the media industry. Then, the dot-com crash happened, and New York did not have an established ecosystem, like the one in Silicon Valley, to support its technology startups. The few entrepreneurs who persevered formed the base of the first entrepreneurial generation who led the development of the ecosystem later on [39]. The business capital of the world, center of advertising, center of the financial industry, center of the food industry, center of the fashion industry, supported by a robust high-tech entrepreneurial policies system and a strong pool of human capital blossomed into FinTech, FashionTech, FoodTech, MarketingTech, AdTech, Marketing Tech, Real Estate Tech, and so on.

We have heard from many interviewed specialists that each ecosystem has expertise in a few specific industries. While Boston is a worldwide leader in areas like pharma and biotech [40], NYC is strong in media and financial (FinTech) startups. A global trend is that building a business is becoming cheaper and cheaper because of the easy access to basic resources (computer infrastructure via cloud services, Software as a Service, Open Source software), and the mobile Internet connected world.

By analyzing the proposed ecosystem maturity model [35] with New York observations and feedback from specialists at the PROFESS’2015 Software Startups Workshop, we refined some of its proposed factors. For example, we replaced the absolute number of startups in an ecosystem by the relative number of startups per million inhabitants. Actually, all factors that considered absolute numbers were revised to use values that are relative to the ecosystem size. Otherwise, ecosystems outside very large cities would never reach their maturity if the criteria of having high absolute values were required. We also had assistance and valuable feedback from one of the authors of the Startup Ecosystem life cycle model, a similar approach to design and map ecosystems evolution [41].

Two new essential factors were added to the maturity model:

1. **Access to Angel Funding.** “Startup communities feel like they are not complete until they have at least one angel investor group” [39]. Many interviewees mentioned the great importance of role models. For

technology startups, it is important that these role models include not only successful business people, but also developers and tech leaders. One of the entrepreneurs interviewed said “I think it is essential to give a lot of equity to engineers. When a company becomes successful and these guys become rich, they are the ones who will start new innovative companies”. Successful tech founders will not only inspire new entrepreneurs, but also will become angel investors for the next generations.

2. **Events:** it is nearly unanimous among the New York City interviewees that social networking spaces and events are important to the ecosystem’s maturity.

Backed by interviews and reflections with experts in startup ecosystems, another modification we made to the model was to remove **access to funding** from the essential factors list. Even if access to funding is very important, it is more a side effect than a cause of success for ecosystems. One investor said: “When you have amazing technology companies being created anywhere, investors will follow”.

For ease of understanding and to facilitate dissemination, we created a summarized version of the model depicted in Table 1. To classify the maturity level by using this summarized version, the analyzed ecosystem must have a minimum of seven (from eight) factors classified on that level. A full explanation of the startup ecosystem maturity model is available as a technical report ³.

Table 1 - Startup Ecosystem maturity model - summary

Maturity Factor	M1 Nascent	M2 Evolving	M3 Mature	M4 Self-sustainable
Exit strategies	<i>none</i>	<i>A few</i>	<i>several M&A few IPO</i>	<i>several M&A and IPO</i>
Entrepreneurship in universities	<2%	2-10%	~ 10%	>= 10%
Angel Funding	irrelevant	irrelevant	some	many
Culture values for entrepreneurship	< 0.5	0.5 – 0.6	0.6 – 0.7	> 0.7
Specialized Media	no	a few	several	plenty
Ecosystem data and research	no	no	partial	full
Ecosystem generations	0	0	1-2	>=3
Events	monthly	weekly	daily	> daily

If we consider the New York ecosystem evolution from 2000 to 2015, the new model fits perfectly: the ecosystem passed through all 4 stages. Moreover, some initiatives taken by stakeholders when the ecosystem was considered **nascent** or **evolving** (such as the creation of the New York Tech meet-

³ Available at <http://bit.ly/ime-usp-startups>

up⁴), and other events that happened later when the ecosystem was already considered Mature (such as the Cornell Tech project [42]), came at the right moment for the ecosystem and helped it to evolve quickly and robustly. Based on our research in Israel [43], we consider that the Tel Aviv ecosystem is in the same **self-sustainable** stage as New York, and took similar evolutionary steps. Our research in São Paulo concludes that this ecosystem already passed the **nascent** stage, but is still at the Evolving stage. The characteristics and dynamics of all these three ecosystems fit the proposed maturity model. The reason we chose Tel Aviv was to analyze evolved ecosystems outside the USA market and avoid bias on US culture-specific characteristics. The choice of São Paulo, besides being the ecosystem two of the authors were immersed in, was because of the importance of investigating ecosystems in a more immature stage and understanding the specific needs in this context.

In the late 1990s, New York City was in its **nascent** maturity level and already had a lot of the necessary support infrastructure to evolve quickly: the metropolitan region is home to top research universities like Cornell, Columbia, New York University, and the City University of New York and all these institutions have special programs for entrepreneurs; many (sometimes free) co-working spaces like General Assembly and WeWork (which was valued \$17 billion in 2016) started to emerge; the public transportation system is efficient; big tech companies established offices in the city (like Google's in the Chelsea neighborhood).

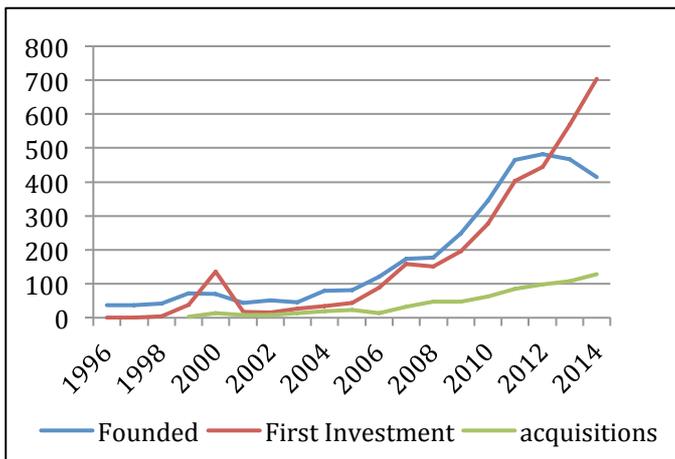


Figure 2 - Companies founded in New York and number of first investment deals per year. Source: Our graph from raw Crunchbase data.

⁴ The New York tech meet-up is a monthly tech startups gathering, where entrepreneurs pitch their project to the general audience, some investors and potential customers.

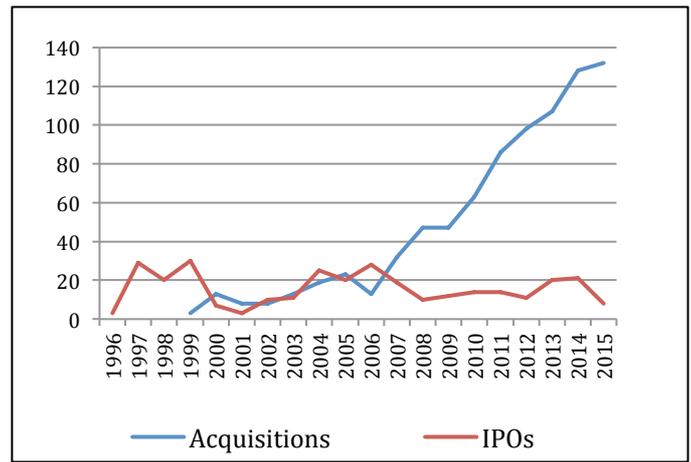


Figure 3 – New York startups acquisitions and IPOs. Source: Our graph from raw Crunchbase data.

The Boulder Thesis [44] states that a prosperous ecosystem has four characteristics: (1) it is led by entrepreneurs; (2) it is inclusive where everyone is welcomed; (3) the involved people are committed long-term (at least 20 years) to the ecosystem; and (4) there are many opportunities for gathering, i.e., a lot of events. New York is a perfect observation instance of the Boulder Thesis:

- Even if part of the NYC impetus for the ecosystem came from direct efforts of the Bloomberg Administration (i.e., the Mayor's Office) – supporting incubators, accelerators, and co-working spaces – entrepreneurs are still the central agents, as everything starts with them. An interviewed entrepreneurship professor remarked: “put two or three great entrepreneurs anywhere and they will create an ecosystem”. The idea that entrepreneurs are the center of the ecosystem challenges the triple helix model [45], built on the idea that the regional innovation hubs emerge only from the collaboration among university, industry, and government.
- Events are made visible and discoverable, to bring people together and create a community. The New York Tech meet-up has 50 thousand members, it is the biggest tech meet-up in the world. In 2014, the City officially launched Digital.NYC⁵, an online hub for the startup ecosystem, bringing together every startup, investor, event, class, job opening, workspace, accelerator, news story, blog, video and startup resource. Small events happen every day, medium events happen every week, and large events every month.
- Inclusiveness: everybody is welcome to NYC. It is a cultural mix. When you look at startups, you find founders from dozens of different nationalities. There are twice as many startups founded by women than in

⁵ This has since been duplicated by both London and Boston, and was cited in the CITIE Accenture study as one of the significant factors propelling NYC to its current #1 position in the rankings of startup ecosystems.

Silicon Valley [39]. The NYC Tech meet-up and other events involve people of all ages, from elderly to children watching startup pitches.

- Long-term commitment: the first generation of entrepreneurs that led their startups to successful exits and helped to found the New York Angels, and many other investment groups, is a good example of persistent commitment. So is the Cornell Tech program that was planned between 2009-2011. Its intent was to create high-tech and applied science entrepreneurship courses and build a new campus on Roosevelt Island. The construction project began in 2014, is expected to be open in 2017 and finished in 2037. It received donations from many Cornell alumni, including a very large one from Charles “Chuck” Feeney of US\$350 million [42] and one of US\$133 million from Joan and Irwin Jacobs to fund the Technion-Cornell Institute.

The combination of this long-term commitment by entrepreneurs with the many startup events that are inclusive leads to a highly connected ecosystem. Theory shows how connectivity is crucial to ecosystem success [46] and our observations and interviews showed that New York has a high degree of connectivity. There are several entrepreneurship networks. Also, successful business such as DoubleClick that was bought by Google created a network effect. Howard Morgan, one of the founders of New York Angels explains why: “exits like that (US\$ 1.1 billion) are essential to grow the high-tech ecosystem, because managers and engineers who have made some money (...) can then take some risks in other startups” [39].

A recent industry report for startup ecosystem rankings shows the New York City ecosystem evolving from the 5th place in 2012 [47] to the 2nd place in 2015 [40]. Another report put New York in the first place in 2015 [48]. If these reports existed before, and considering the criterion used on those reports, probably New York would not be among the top ranked ecosystems before 2009.

Many theoretical models about entrepreneurship regions point to culture as a very important dimension when analyzing these ecosystems [49][32][50]. We observed a cultural shift in New York City after the 2009 crisis. Many interviewees commented that before the crisis, high-qualified engineers were comfortable with the salaries paid by their employers in the financial market. When the market crashed, many tech talents lost their jobs and realized that they were not as safe as they believed. The opportunity cost of starting a new company seemed smaller and taking the risk was no longer a big issue. Because of the traditional financial market crash, many investors started to look for new investment opportunities. Moreover, the financial district office spaces were completely empty and rental prices went down. To promote the recovery of real estate, financial district owners offered free co-working space for new startups, with the hope that their growth in the future could bring more real estate business to the district.

The financial crisis in 2009 also had impact on people’s decision to invest time in high-level education. In fact, “New York has more college students than there are people in Boston”, affirmed one of the interviewed entrepreneurs.

Another entrepreneur emphasized his move to PhD because of the crisis: “when the market crashed, I didn’t know what I was going to do, then an opportunity arose to do a PhD and then I thought that was great because there was nothing else to do”.

By analyzing raw data from Crunchbase, one of the biggest and most complete startup databases in the world, we created two graphs that show the evolution of the New York Ecosystem. Looking at Figure 2, we observe an explosion of new startups being created in New York since 2009. The same degree of growth happened to the number of companies that got their first investment. Figure 3 shows that, even if the number of IPOs remained static within the ecosystem, the number of acquisitions grew at the same pace as the creation of new companies or investment deals.

In New York City, the very first technology startups appeared in the mid-1980s, but it wasn’t until the mid-1990s that New York first high-growth startups began to emerge in the media industry. The ecosystem experienced a modest growth during the 2000s, passing from a **nascent** stage to an **evolving** stage during these years. This first evolution was observed in the following metrics of the maturity model: growing number of events, the first large startup exits, and the first specific university programs. In the beginning of the 2010s, it reached the **mature** stage (increased number of M&A and IPOs, a 2nd generation of entrepreneurs, growing angel investment groups) on its way to reaching a **self-sustainable** stage in the last couple of years.

We observe this evolution not only in the number of startups and investment deals, but also in other factors such as events frequency, support from big tech companies (like the first Cornell Tech course in Google’s office), co-working spaces, etc. After 2010, the ecosystem started the path of a virtuous cycle when the older generation of successful entrepreneurs became angel investors or serial entrepreneurs. In addition, after 2012, the number of startup acquisitions per year exploded (almost one every three days), a prosperous environment for investors and entrepreneurs. Something that is worth noting is that, since 2011, the number of new companies did not grow as much as the number of investment deals or acquisitions. This shows a tendency of abundance in access to funding in the last years or a saturation of talent availability, suggesting that the ecosystem has space for more startups and needs more investment to attract and retain talent.

In summary, the answer to our four research questions, in the context of the NYC case study, were the following:

A. What are the minimum requirements for a startup ecosystem to exist in its nascent stage?

Fred Wilson, co-founder and managing partner of Union Square ventures, claim that “the story of NYC is a story of entrepreneurship (...), entrepreneurs re-investing their wealth back into the next generation of entrepreneurs. (...)” [39] – it follows that one of the first requirements for an ecosystem to exist is to have great entrepreneurs. It seems obvious that any entrepreneurial ecosystem needs entrepreneurs, but it is not so obvious that the entrepreneurs are the seed of everything. This means that talented entrepreneurs are necessary even at the first **nascent** stage of an ecosystem.

The existence of high-quality research universities in the region is an important attractor for these talents, especially when there are programs for tech-entrepreneurship. The presence of big tech companies can also be considered a talent attractor, but not necessarily the talents that will become entrepreneurs.

B. What are the requirements for a startup ecosystem to exist as a mature self-sustainable ecosystem?

Startup ecosystems reach a mature self-sustainable level when there are at least three generations of successful entrepreneurs that start re-investing their wealth in the ecosystem by becoming angel investors and offering their mentorship. This is only possible when there are many opportunities for M&A and IPOs in the market. Moreover, the entrepreneurial culture is widely accepted and understood, being supported by high-quality educational institutions, and the occurrence of many startup events happening almost every day. When the ecosystem reaches the self-sustainable maturity level, the media also plays the role of keeping the momentum and awareness of the public.

C. What are the stages that ecosystems pass through? Can they regress or die?

Our interviews and observations led to the definition of four stages that ecosystems pass through: **nascent**, **evolving**, **mature** and **self-sustainable**. The transition between stages is smooth and may take years. The classification is sometimes fuzzy, especially during the transition between phases.

It is possible that Startup ecosystems can regress, but it is rare. An angel investor and serial entrepreneur explains: “the ecosystem evolution is a one-way street, because created conditions are self-reinforced”. “Very drastic situations like wars or natural disasters can eventually lead the ecosystems extinction” – said another entrepreneur: “These are very rare situations, thus the natural path is evolution” [46]. We would also add as a threat to this evolution persistent economic crisis in the country in which the ecosystem is inserted.

D. Can people proactively interfere in the evolution of ecosystems? Is it possible to exist other ecosystems as evolved as, e.g., the Silicon Valley?

Fred Wilson adds that “what has happened in NYC can happen anywhere that has the entrepreneurial spirit and the freedom to innovate” [39] – many interviewees agreed that it is possible for self-sustainable ecosystems to exist if the local culture values the entrepreneurial behavior, confirming Brad Feld’s claim that “You can create a vibrant long-term startup community anywhere in the world” [44]. Two interviewees compared New York with Boston, claiming that Boston’s ecosystem (the home of MIT) did not take off as fast as New York because Boston’s culture is much more conservative, while New Yorkers are more open to risk. Thus, on the one hand, people can interfere to accelerate. But, on the other hand, culture, which is something very difficult to change in the short term, plays a very significant role.

We learned from previous research in São Paulo that culture can change, though it may take time. There, the first generation of tech entrepreneurs started timidly in 2000. At that time, young people were supposed to finish their university

degrees and find a job. After 15 years, the scenario changed to a culture where being an entrepreneur is a lifestyle. São Paulo is a city with many characteristics similar to New York: a big metropolis, with millions of people (mostly first, second and third generation immigrants); a financial, advertising, and business center; and a culture of hard work, where time is money. São Paulo has all the potential to evolve from the current Evolving (M2) level to Mature (M3) or even self-sustainable, but for that, it must overcome important obstacles like developing more policies for tech-talent attraction; reducing the tax burden; improving the law framework for company creation and closing; and advancing the investment market.

V. CONCLUSIONS, LIMITATIONS AND FUTURE WORK

The evolution of the New York startup ecosystem from 2010 to 2015 is impressive. The 2009 financial crisis played a very important role, causing talent to migrate from traditional and established markets to startups. This isolated fact does not explain, alone, the rapid ecosystem growth. But when human talent is available to work in innovative startups and these startups have all the infrastructure resources they need to develop, magic happens.

The New York case is a good example of how it is possible for a startup ecosystem to evolve over time. In 2010, this ecosystem had a very modest impact in terms of startup creation and innovation generation compared to other ecosystems such as Silicon Valley, Boston, or Tel-Aviv. Less than 5 years later, the New York City ecosystem is considered a benchmark, the first place for startups according to CITE 2015 Report [48], and the second best place in the Global Startup Ecosystem Ranking [40].

One limitation of this case study is that all interviewees are biased by their knowledge of what today is considered a successful path for technology startups: founding a company, raising seed capital from angels, raising series investment from VCs, becoming a unicorn (US\$1 billion company), going public or being acquired. The media emphasize only the successful cliché cases, and entrepreneurs are overwhelmed with these perfect models. Usually, they ignore medium and small local companies that we suppose may also have an important impact on the startup ecosystem. Their influence and role were not considered in our study and need to be further investigated.

As future work, we would like to collaborate with other researchers in using the maturity model to analyze their regions and derive concrete actions that should be taken to improve their ecosystems. Some questions that still remain open are: is there a limit for how many self-sustainable ecosystems can exist? To what extent does local culture influence the appearance of these ecosystems, being a limiting factor for all other aspects of the model? Since theory emphasizes the importance of the ecosystem connectivity, we also propose that new research should focus on ways to measure an ecosystem’s connectivity based on online social network data.

ACKNOWLEDGMENT

We would like to thank all New York ecosystem agents that offered us their valuable time to participate in the

interviews. We thank JF Gauthier from Compass, with whom we had fruitful discussions and insights about the topic. Thanks to Eduardo Karpat for hosting us in New York during part of our stay, making this research economically viable. CNPq, Brazil, proc. 485070/2013-8, supports this research.

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