

Startup Ecosystem Maturity and Visualization: The Cases of New York, Tel Aviv, and San Paolo



Daniel Cukier, Fabio Kon , Enxhi Gjini, and Xiaofeng Wang 

Abstract A healthy startup ecosystem, an environment with a well-balanced variety of agents and supporting processes, is crucial for the development of innovative startups. However, not all startup ecosystems are equally developed, and it is difficult to have all the elements of a startup ecosystem in advanced and prolific states, especially due to the fact that startup ecosystems are dynamic and evolve over time. In this chapter, we present a maturity model for startup ecosystems, which is built upon an analysis of three major startup ecosystems—Tel Aviv, São Paulo, and New York. We also present the visualization of the maturity model enabled by a web-based application that provides a user-friendly graphical representation of the maturity of a startup ecosystem. The chapter demonstrates that the maturity model, aided by the proper visualization, can serve as a basis for stakeholders in a startup ecosystem to analyze their environment, identify weak spots, and propose policies and practical actions to improve their ecosystem over time.

Keywords Startup ecosystem · Maturity model · Visualization

1 Introduction

In the era of quick technological advancements, startups, the entrepreneurial ventures, are the new companies that are changing the world, revolutionizing entire industries with innovative solutions. Boosted by the Internet, the omnipresence of mobile devices and the abundance of cloud-based services, software startups with scalable business models are an important element in the modern economy. Correspondingly, startup ecosystems have also gained increasing significance. These

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179

ecosystems are very dynamic environments that include many startup companies in different stages of development, various types of organizations, and people, all being in continuous interaction with one another.

Startup ecosystems are not static entities. They are similar to biological ecosystems, behaving like living organisms and changing over time. Some startup ecosystems have existed for over 50 years, while others are newly born. This difference in evolution and maturity makes comparing them a challenge. Moreover, if they are to evolve toward fruitful and sustainable environments, nascent ecosystems need a clear vision of how to develop their community.

Considering 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 is why having a way to measure the maturity level of an ecosystem with respect to multiple factors would be useful for comparing different realities and also proposing practical actions that can help existing ecosystems improve.

Maturity models have been used in the software industry as a tool to assess people, culture, processes, and technologies [1]. These models define a methodology to evaluate software development companies and IT management processes. They are not prescribed processes themselves, but descriptions of the characteristics of effective processes. The application of maturity models has been widened to more than 20 other domains during the last two decades. However, classifying the maturity of a startup ecosystem in a city is very different from classifying software development processes in a company. When deciding the maturity of a startup ecosystem, it is important to analyze both its static characteristics and its dynamics, to emphasize the relationships among ecosystem agents instead of only describing the elements as isolated entities, and to map the key factors of each maturity level as well as the path to the next level [2]. With such a maturity model, it is possible not only to compare different ecosystems, but also to identify gaps and propose customized practical actions that can yield meaningful improvement and lead ecosystems to the next level of development.

In this chapter, we describe a recently developed maturity model of startup ecosystems by two of the coauthors [2]. The model was developed drawing upon an extensive empirical study of three ecosystems in three different geographical regions: Tel Aviv, New York, and São Paulo. It sheds light on the characteristics and dynamics of startup ecosystems as well as their evolution path. The description is enriched by a set of visuals rendered through a web application that implemented the maturity model.

2 A Startup Ecosystem Maturity Model

The theoretical grounding of the maturity model is a conceptual framework for startup ecosystems developed after an extensive literature review on startup ecosystems and a detailed qualitative research conducted in two existing ecosystems: Tel Aviv [3] and São Paulo [4]. Two different techniques were applied during the

period of the empirical study: (1) a multiple case study involving 80 semi-structured interviews conducted with key players of both ecosystems, including entrepreneurs, educators, executives investors, etc. and (2) a systematic workshop/focus group conducted in São Paulo.

Four maturity levels of a startup ecosystem:

- M1: Nascent
- M2: Evolving
- M3: Mature
- M4: Self-sustainable

The conceptual framework, illustrated in Fig. 1, clearly represents a set of important elements that play key roles in a startup ecosystem, including Startup, Entrepreneur, Market, Legal frame, etc., and a wide number of relationships among them. The relationships in the conceptual framework have two graphical representation: (1) continuous arrows, which represent the primary relationships that exist in a startup ecosystem almost all the times; (2) dotted arrows, which illustrate the relationships that are spotted only part of the times. The type of a relationship is defined by the label positioned close to an arrow.

The conceptual framework was essential in the creation of the maturity model. By an in-depth analysis of the collected empirical data, the main elements of the conceptual framework were transformed into a list of 22 factors. The factors were categorized in two groups: essential and complementary factors. The essential factors are important to take into consideration when a specific level of maturity has been reached by the ecosystem, while the complementary ones are important in advancing the ecosystem to the next maturity level. By evaluating each of these 22 factors and classifying the possible results, a scale was created, containing for each factor three possible levels of advancement: L1, L2, or L3. Table 1 shows the list of factors and the defined scales (see [2] for a detailed definition of all the factors).

Based on the percentage of the factors at each level (L1, L2, or L3), four maturity levels were defined [2]:

- Nascent (M1): In this state, the startup ecosystem is already recognized as a startup hub, with already some existing startups, a few investment deals, and government initiatives to stimulate or accelerate the ecosystem development. However, there is still no great output in terms of job generation or worldwide penetration.
- Evolving (M2): In this state, the startup ecosystem is in the evolving stage with a few successful companies which also have regional impact, job generation, and a small local economic impact. To be at this level, the ecosystem must have all essential factors classified at least at L2, and 30% of complementary factors also at L2.

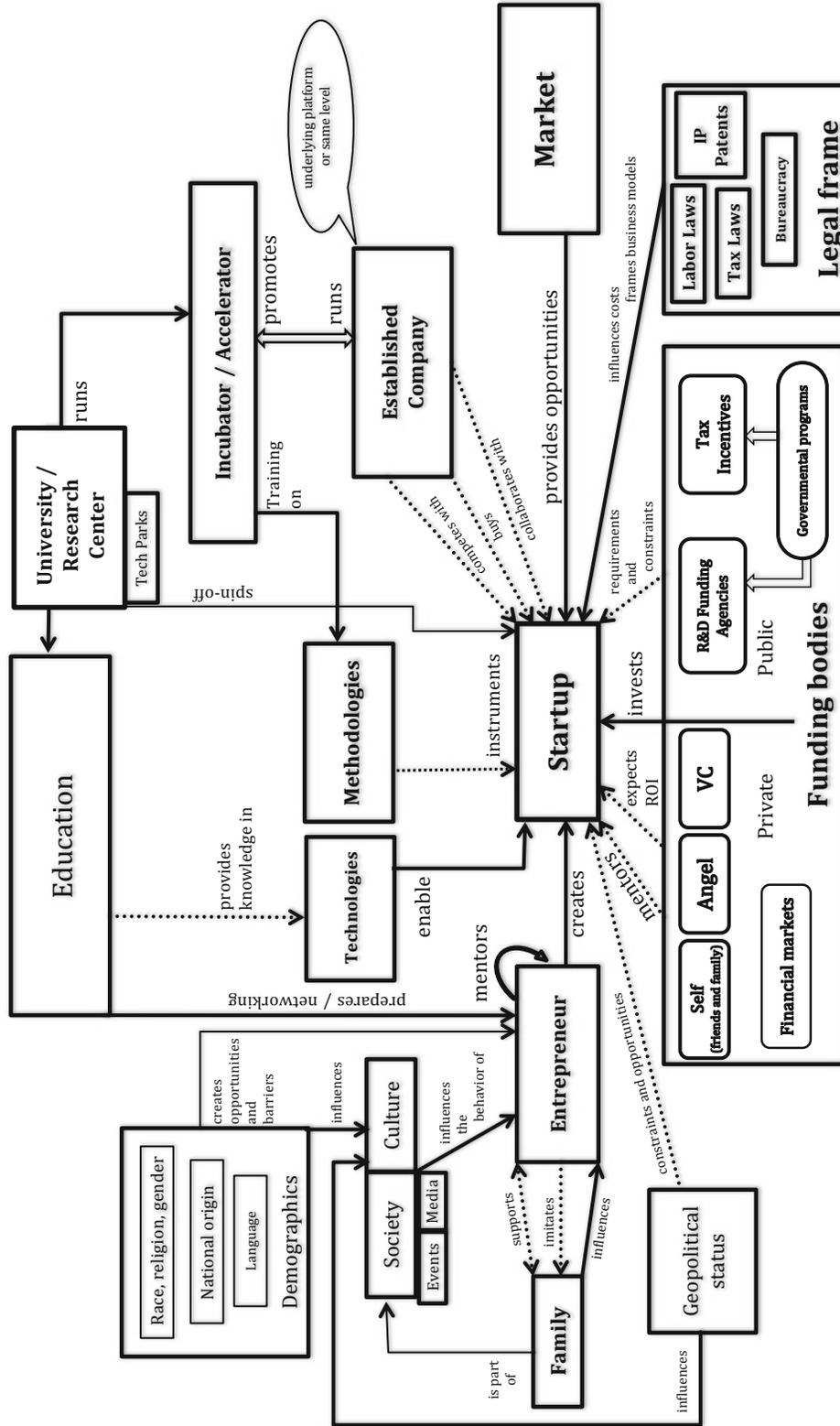


Fig. 1 The conceptual framework behind the maturity model, excerpted from [2]

Table 1 The startup ecosystem maturity model, adapted from [2]

Factors	Level of advancement		
	L1	L2	L3
Exit strategies ^a	0	1	≥2
Global market ^a	<10%	10–40%	>40%
Entrepreneurship in universities ^a	<2%	2–10%	>10%
Culture values for entrepreneurship ^a	<0.5	0.5–0.75	>0.75
Startup events ^a	Monthly	Weekly	Daily
Ecosystem data and research ^a	N/A	Partial	Full
Ecosystem generations ^a	0	1	≥2
Mentoring quality	<10%	10–50%	>50%
Bureaucracy	>40%	10–40%	<10%
Tax burden	>50%	30–50%	<30%
Accelerators quality (% success)	<10%	10–50%	>50%
Access to funding in USD/year	<200M	200M–1B	>1B
Human capital quality	>20th	15–20th	<15th
Technology transfer processes	<4.0	4.0–5.0	>5.0
Methodologies knowledge	<20%	20–60%	>60%
Specialized media players	<3	3–5	>5
<i>Relative measured factors (per 1 million inhabitants)</i>			
Number of startups ^a	<200	200–1k	>1k
Angel funding in number of deals/year ^a	<5	5–50	>50
High-tech companies presence ^a	<2	2–10	>10
Access to funding in number of deals/year	<50	50–300	>300
Incubators/tech parks	1	2–5	>5
Established companies influence	<2	2–10	>10

^a Essential factors

- Mature (M3): In this state, the startup ecosystem includes hundreds of startups, where there is a considerable amount of investing deals, existing successful startups with worldwide impact, and a first generation of successful entrepreneurs who help the ecosystem to grow and be self-sustainable. To be at this level, the ecosystem must have all essential factors classified at least at L2, 50% of complementary factors also at L2, and at least 30% of all factors at L3.
- Self-sustainable (M4): In this state, the startup ecosystem includes thousands of startups and financing deals, at least a second generation of entrepreneur mentors, especially angel investors, a strong network of successful entrepreneurs engaged with the long-term maintenance of the ecosystem, and an inclusive environment with many startup events and high-quality technical talent.

Table 2 The metrics importance for each maturity level, adapted from [2]

Maturity metric	Maturity level			
	M1	M2	M3	M4
Exit strategies	a	a	c	c
Entrepreneurship in universities	c	c	b	a
Angel funding	a	a	b	c
Culture values for entrepreneurship	c	c	c	b
Specialized media	a	b	c	c
Ecosystem data and research	a	a	b	c
Ecosystem generations	a	a	b	c
Events	c	c	b	a

^a Not so important

^b Important

^c Very important

The maturity model also includes a simplified metrics importance table (as shown in Table 2) which indicates how significant a factor is in each one of the maturity states. This can be helpful for the main players in a startup ecosystem by showing them where they should focus their efforts for the ecosystem's development.

The presented maturity model has been validated and refined through an extensive case study of the New York startup ecosystem.

After the maturity model validation, we developed a web-based application to provide a graphical and interactive interface to the maturity model. The objective is to represent the model in an easier to understand and usable manner, and to enable different stakeholders to explore the characteristics and status of a startup ecosystem, without the preknowledge of the maturity model underneath.

3 The Maturity of Three Startup Ecosystems

Tel Aviv, São Paulo, and New York startup ecosystems were investigated in the process of building the maturity model, and their maturity evaluations are presented in this section.

3.1 An Overview of the Three Startup Ecosystems

Tel Aviv Startup Ecosystem Israel is well known as a startup nation [5], and is reputed to have the most startups per capita. Most startups in Israel are located in

Tel Aviv, which is a highly ranked startup ecosystem with global fame. Despite the history of conflicts and tensions, Tel Aviv has become a leader in launching high-tech businesses. Being a country with a small population and a paucity of natural resources, Tel Aviv and Israel in general have to rely on alternative resources, especially people. Israel's mandatory military service is a contributing factor in this aspect, as it exposes young people to accountability and responsibility.

After certain economic difficulties in the 1980s and a change in the government toward a more liberal view of the economy, public policies changed toward strengthening the private sector. Although still with a strong well-fare state and government-supported funding for health, education, and research, nowadays, the private sector is the one that drives most of the Israeli innovation and economy. Beginning in the 1970s, large high-tech multinational companies started to establish research and development (R&D) centers in Israel attracted by the comparatively cheap, high-quality scientific and engineering labor. Nowadays, Israel hosts R&D centers from most major IT companies in the world, including Intel, IBM, Microsoft, Google, HP, Yahoo!, Facebook, Oracle, SAP, Cisco, Siemens, and Motorola [3].

São Paulo Startup Ecosystem São Paulo is the largest Brazilian city, the 12th largest city in the world. It is the financial center of Brazil and hosts the headquarters of many major companies and banks, including many foreign companies doing business in Brazil. São Paulo is home to the Bovespa, the largest stock and bond exchange in Latin America. It has several leading science and technology universities. Foremost among them is University of São Paulo (USP), founded in 1934, one of the largest universities in the world, with more than 90,000 students (of whom almost one-third are masters and doctoral students); 4 of its 11 campuses are located in the São Paulo metropolis [4]. The city concentrates over 60% of startup investments in Brazil and well over 2000 ventures working on tech-based products and services.

São Paulo is the Latam base of many Fortune 500 companies and tech giants like Spotify, Airbnb, Google, Netflix, and Amazon. It is also home to many local unicorns, including 99 (sold to Didi), PagSeguro (IPO at NYSE), Nubank (now a decacorn valued at US\$10B), Stone (IPO at NASDAQ), and iFood.

New York Startup Ecosystem New York City is the business capital of the world, as well as the center of advertising and the financial, food, and fashion industry. It is supported by a robust high-tech entrepreneurial policies system and a strong pool of human capital, blossomed into FinTech, FashionTech, FoodTech, AdTech, Marketing Tech, Real Estate Tech, and so on.

In the late 1990s, New York City was in its nascent phase and had already acquired much 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, which all 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; and big tech companies established offices in the city (for instance, Google's office in the Chelsea neighborhood).

3.2 The Maturity Levels of the Three Ecosystems

Applying the maturity model described in Table 1, the maturity levels of the three ecosystems were evaluated as shown in Table 3.

The analysis of the three startup ecosystems at two different maturity levels, and their evolution through the maturity levels, revealed many insights regarding how a startup ecosystem can evolve healthily. Among them, several key points are:

The Minimum Requirements for a Startup Ecosystem to Exist in Its Nascent Stage One of the first requirements for an ecosystem to exist is to have great entrepreneurs. It seems obvious that any startup 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 all the talents will become entrepreneurs.

By analyzing the three startup ecosystems, it is clear that all of them surpassed the nascent stage.

The Requirements for a Startup Ecosystem to Be Self-Sustainable A startup ecosystem reaches a self-sustainable level when there are at least two generations of successful entrepreneurs that start reinvesting their wealth in the ecosystem by becoming angel investors and offering their mentorship. This is only possible when there are many opportunities for merge and acquisition (M&A) as well as initial public offerings (IPOs) in the market, and, moreover, when the entrepreneurial culture is widely accepted and understood, supported by high-quality educational institutions, and startup events happen almost every day. When the ecosystem reaches the self-sustainable maturity level, the media also plays the role of maintaining the momentum and awareness of the public.

Both Tel Aviv and New York are considered to have reached the self-sustainable maturity level. On the other hand, São Paulo has not reached this stage yet, since

Table 3 The detailed information on the maturity levels of the three startup ecosystems, adapted from [2]

Factor	Startup ecosystem		
	Tel Aviv	São Paulo	New York
Exit strategies ^a	L3	L2	L3
Global market ^a	L3	L2	L3
Entrepreneurship in universities ^a	L3	L2	L3
Culture values for entrepreneurship ^a	L3	L2	L3
Startup events ^a	L3	L2	L3
Ecosystem data and research ^a	L3	L2	L3
Ecosystem generations ^a	L3	L2	L3
Mentoring quality	L3	L2	L3
Bureaucracy	L2	L1	L3
Tax burden	L2	L1	L3
Accelerators quality (% success)	L3	L1	L3
Access to funding in USD/year	L3	L2	L3
Human capital quality	L3	L2	L3
Technology transfer processes	L3	L1	L3
Methodologies knowledge	L2	L2	L2
Specialized media players	L2	L2	L3
Number of startups ^a	L3	L2	L3
Angel funding in number of deals/year ^a	L3	L2	L3
High-tech companies presence ^a	L3	L2	L3
Access to funding in number of deals/year	L3	L1	L3
Incubators/tech parks	L3	L2	L3
Established companies influence	L3	L2	L3
Essential factors	L3(10)	I2(10)	L3(10)
Complementary factors	L2(4)	L1(5)	L2(1)
	L3(8)	L2(7)	L3(11)
Maturity level	Self-sustainable (M4)	Evolving (M2)	Self-sustainable (M4)

^a Essential factors

the required characteristics, such as an evolved IPO market or two generations of successful entrepreneurs, do not exist in the ecosystem.

The Evolution of a Startup Ecosystem It is possible for self-sustainable ecosystems to exist if the local culture values the entrepreneurial behavior. For instance, when comparing New York with Boston, the startup ecosystem in Boston (the home

of MIT) did not take off as fast as that in New York, because the local culture of Boston is much more conservative, while New Yorkers are more open to risk. Entrepreneurial culture, which is something very difficult to change in a short term, plays a significant role in the evolution of a startup ecosystem.

The maturity levels of three major startup ecosystems:

- Tel Aviv: Self-sustainable (M4)
- São Paulo: Evolving (M2)
- New York: Self-sustainable (M4)

Nevertheless, the evolution of São Paulo startup ecosystem shows 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 in which being an entrepreneur is a lifestyle. São Paulo is a city with many characteristics similar to New York: a large 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 evolving (M2) level to mature (M3) or even self-sustainable, but for that to happen, 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; investing in mobility infrastructure to facilitate access to high-quality universities; and advancing the investment market.

It is important to emphasize that the maturity levels of the three startup ecosystems reported in this chapter were evaluated based on the data collected in 2015 and 2016. Tel Aviv and New York were already at M4 (self-sustainable) maturity level at that moment, and so there would be no big difference compared to their maturity levels in 2019. São Paulo, on the other hand, has much evolved in the last several years. Even though it is subject to further research, it is quite probable that the maturity level of São Paulo startup ecosystem has reached M3 (mature) level in 2019.

4 Startup Ecosystem Maturity Visualization

In this section, we present a web-based application that implemented the maturity model. It provides a graphical and interactive user interface to explore the maturity evaluation of startup ecosystems.

The web application provides three levels of representation of the maturity of a startup ecosystem:

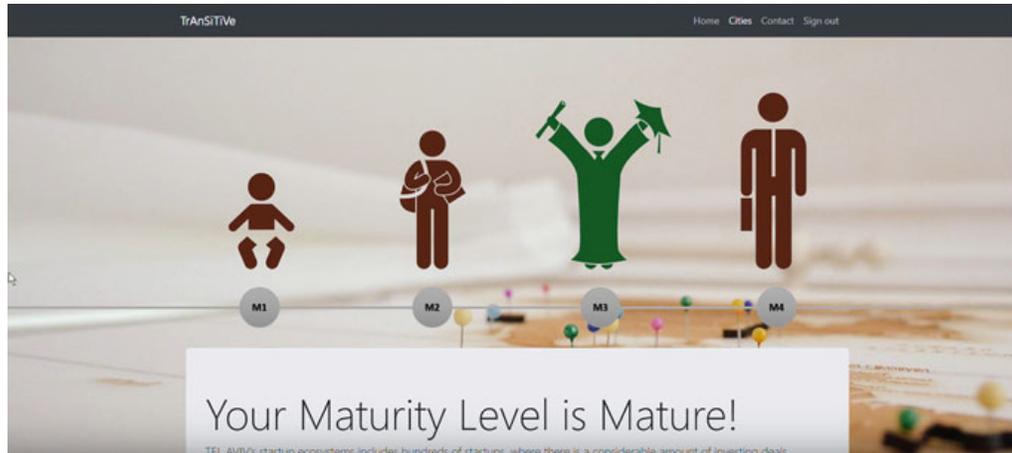


Fig. 2 The illustration of the overall maturity level of São Paulo startup ecosystem

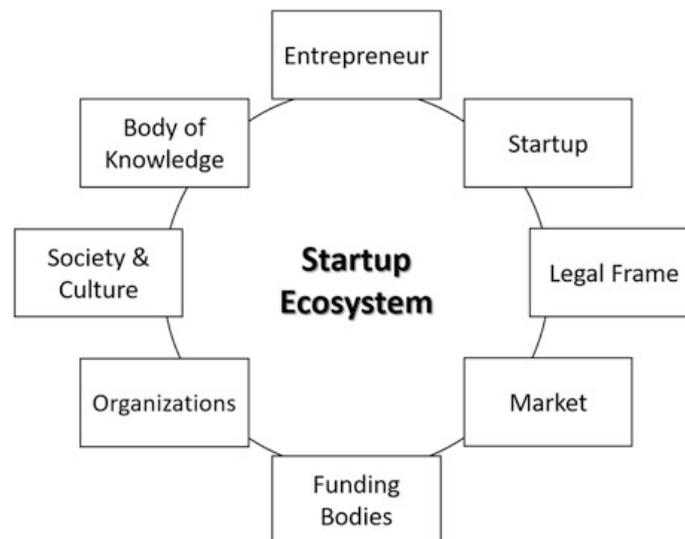


Fig. 3 The dimensions of the startup ecosystem factors

- A general view of the overall maturity level (M1, M2, M3, or M4)
- A clustered view of the maturity level along eight dimensions
- A zoomed-in view of one dimension with the clustered factors, their levels of advancement, and the explanation and advice related to that dimension

The overall maturity level of a startup ecosystem is visualized in a fairly straightforward manner, e.g., as shown by Fig. 2.

To visualize the detailed evaluation of the 22 factors and their levels of advancement (as explained in Table 3), we clustered the factors into 8 different dimensions. Figure 3 is the schema of this clustering. To visualize each dimension, we needed to decide the maturity value of each dimension, which was in turn decided by the levels of advancement of the factors mapped into this dimension. For this purpose, we used calculation tables illustrated by Table 4 for each startup ecosystem (using

Table 4 The clusters of the startup ecosystem factors into dimensions and maturity value calculation

Factors	Dimensions							
	Startup	Entrepreneur	Body of knowledge	Organizations	Society and culture	Funding bodies	Market	Legal frame
Exit strategies ^a	2			2		2		
Global market ^a							2	
Entrepreneurship in universities ^a			2	2				
Culture values for entrepreneurship ^a					2			
Startup events ^a					2			
Ecosystem data and research ^a				2		2		2
Ecosystem generations ^a		2			2			
Mentoring quality		2						
Bureaucracy							1	1
Tax burden				1				1
Accelerators quality (% success)				1				
Access to funding in USD/year						2		
Human capital quality		2	2					
Technology transfer processes			1					1
Methodologies knowledge			2					
Specialized media players					2			

Number of startups ^a	2	2							2	
Angel funding in number of deals/year ^a									2	
High-tech companies presence ^a				2						
Access to funding in number of deals/year									1	
Incubators/tech parks				2						
Established companies influence	2	2		2			2			
Evaluated maturity value of dimension	6	10	7	14			10	9	5	5
Maximum maturity value of dimension	9	15	12	24			15	15	9	12
% (Evaluated value/Maximum value)	0.67	0.67	0.58	0.58			0.67	0.6	0.56	0.42

^a Essential factors

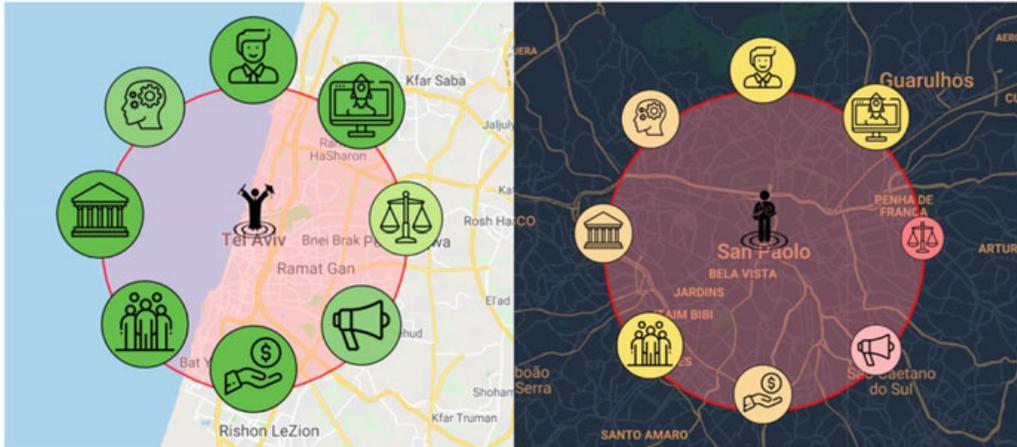


Fig. 4 The clustered view of the maturity level of a startup ecosystem: the examples of Tel Aviv and São Paulo

São Paulo as an example. Note that one factor can be mapped to more than one dimension).

The clustering dimensions and the calculation tables provide the basis to create the clustered view and the zoomed-in view of the maturity of a startup ecosystem, as shown in Figs. 4 and 5. These two views use Google Map to visualize the geographical location of an ecosystem, and also apply the day/night map style, as shown in the two figures.

We have evaluated the web application with several local startup ecosystem stakeholders in Bolzano, Italy. The results were positive from both usefulness and usability perspectives. They pointed to various ways to improve and extend the features of the application, in order to better serve the potential users, who are various startup ecosystem players, and above all, local policy makers.

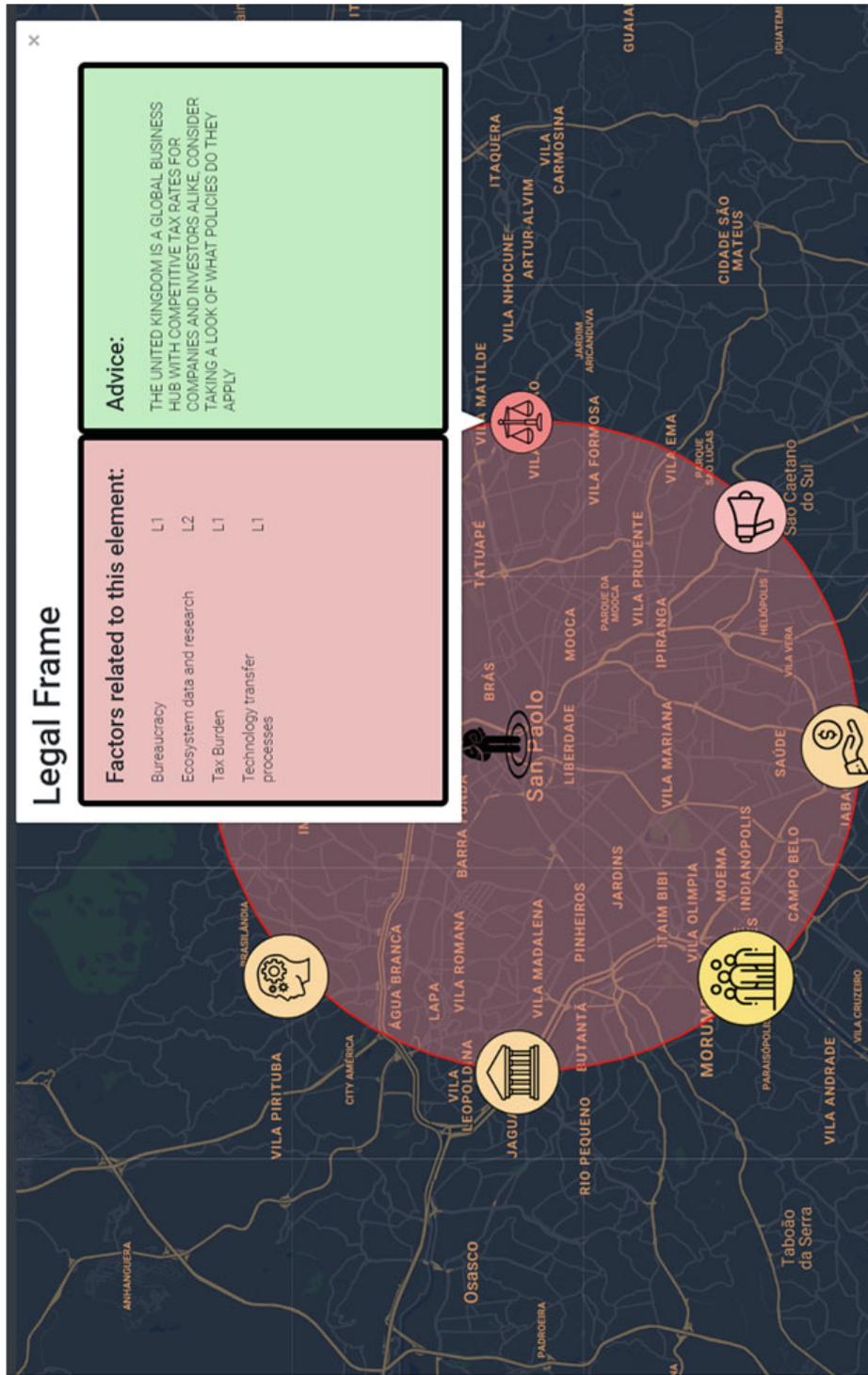


Fig. 5 The zoomed-in view of one dimension of factors from the clustered view: the example of São Paulo

5 Conclusion

A healthy startup ecosystem, an environment with a well-balanced variety of agents and supporting processes, is crucial for the development of innovative startups. However, not all startup ecosystems are equally developed, and it is difficult to have all the elements of a startup ecosystem in advanced and prolific states, especially due to the fact that startup ecosystems are dynamic and evolve over time. In this chapter, we presented the maturity model developed based on the empirical study of three startup ecosystems: Tel Aviv, São Paulo, and New York, and the visualization of the maturity model enabled by a web-based application that provides a user-friendly graphical representation of the maturity of different startup ecosystems.

Our work demonstrates that the startup ecosystem maturity model, aided by proper visualization, can serve as a basis for stakeholders in a startup ecosystem to analyze their environment, identify weak spots, and propose policies and practical actions for improving their ecosystems over time.

Future work regarding the maturity model includes collaborating with other researchers in using the maturity model to analyze new regions and derive concrete actions that should be taken to improve those ecosystems. This research could also be extended to other regions outside from big urban centers. It is a challenge to develop fruitful startup ecosystems in smaller cities. In the long term, small and medium cities tend to loose talent and resources to big centers. We consider that there is a vast field of research to be explored on startup ecosystems in small and medium cities. Regarding the implementation of the maturity model, the next meaningful step would be automating the collection of maturity-related data from various ecosystem stakeholders, which is crucial but effort-consuming, and could be streamlined using automated web-based solutions.

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