Study of the Start-Up Ecosystem in Lima, Peru: Analysis of Interorganizational Networks

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Abstract: According to the literature, In the context of changes at a global level the formation of new businesses drives the economy, being important start-ups, which are linked to a community of entrepreneurs, mentors, incubators, accelerators, providers of common services, angel investors, venture capitalists, universities and public support entities, which together configure an ecosystem that is linked to other ecosystems. In this way, this work focuses on the Lima, Peru ecosystem with the aim of providing an understanding of the interorganizational networks that are established based on the analysis of the interactions that occur in the LinkedIn social network. Definitions, methodology, results and conclusions are presented.

Keywords: innovation ecosystems; entrepreneurial ecosystems; technological entrepreneurship; start-ups; social network analysis; interorganizational networks analysis; linkedin.

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1. Introduction

At the global level, the way to boost the development of the countries' economies is through the creation of new enterprises through entrepreneurship, as this will guarantee jobs and taxes in the future. Due to the need of nations to face new challenges in the coming years, the entrepreneurs and the conditions that allow the phenomenon of entrepreneurship, that is, the ecosystem, have become very important at the academic, business and governmental level (World Economic Forum, 2009; Schumpeter, 1911; Serida, Morales, & Nakamatsu, 2012; OECD, 2009)

According to WEF (2009) it is important to know the ecosystem that houses the enterprises, the elements that make it up and the interaction between them, because this knowledge will allow raising better policies and therefore to improve the conditions in the medium and long term to stimulate the entrepreneurship at the level of sectors, cities and countries.

On the linkages in the technological entrepreneurship ecosystem in Peru, there are documented records in different articles since 2001, on the incubation of companies in Peru and a methodology proposed to guide the development of entrepreneurship from universities (Gonzalez, Vela, & Ochoa, 2001). For 2003, the university-based entrepreneurial potential of the technological base is evaluated; among the evaluated levels is the university networking and the environment (González, Vela, & Ochoa, 2003). In 2004, the PERUINCUBA project (Peruvian Association of Business Incubators) was analyzed and funded by the InfoDev-Incubator program (González & Campelo, 2004). In an earlier research, through a collective case study, it was found that from the perspective of the founders of start-ups there is presence of the different elements in the technological entrepreneurship ecosystem in Lima (Hernández & González, 2016).

In the case of Lima, the entrepreneurial ecosystem dates back to 1880 with the founding of the Lima Chamber of Commerce, founded to contribute to national reconstruction, the defense of private enterprise and free enterprise, fiscal balance, management Transparency of public resources, legal security, investment and savings, as well as their adherence to democracy and respect for human rights (CCL, 2016).

On the other hand, social networks today have been enhanced by the Internet, as demonstrated by the term networking, which is used by different people on a daily basis. The social networks analysis has become a very powerful tool for sociology and its applications in other areas. Being able to be connected through a social network can help through contacts to find a better situation, networks can allow seeing and use information in the most diverse fields, from business to national security, these networks constitute conduits by which flows and collects information and can be used for different purposes (Kadushin, 2013).

One of the most important social networks on the Internet is LinkedIn, which connects professionals from around the world with more than 430 million members (LinkedIn Corporation, 2016b).

In this article we first define the state of the art of the concepts of the technological entrepreneurship ecosystem and its elements, the analysis of social and interorganizational networks, the research methodology to later apply this theory to the collected data of LinkedIn of the elements of the technological entrepreneurship of Lima.

For this, the strategy that is proposed to follow is the literature review on the technological entrepreneurship ecosystem and the elements are contained in this, in addition to the theory of social and interorganizational network analysis and then apply this knowledge to the data collected from LinkedIn.

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2. The entrepreneur and the technological entrepreneurship

The entrepreneur is responsible for economic change and transformation, applying different techniques to achieve his business goals (Esuh Ossai-Igwe & Mohd Sobri, 2011). On the one hand, the business entrepreneur aims at profit and seeks to achieve this goal through innovation to capture an increasing percentage of the market (Zahra & Nambisan, 2012), while the technological entrepreneur depends on the knowledge of others People who have skills and knowledge about different technologies (Hausmann, y otros, 2011).

Entrepreneurship is the process of creating a new company with a series of stages that allow finding, evaluating and developing an opportunity creating something new, and involves different aspects: technological, social, psychological, legal, etc. (Shane & Venkataraman, 2000). These stages are not necessarily sequential but are progressive, being the following: identification and evaluation of the opportunity, business planning, determination of the necessary resources and management of the resulting company (Hisrich, Peters, & Shepherd, 2012).

This research is focused on the entrepreneurship called start-ups, for which according to Startup Commons (2015) and Churchill & Lewis (1983) there are 4 stages: the first is the stage of definition in which the idea is developed, the second is the Validation stage in which a minimum version of the product or service is launched, the third is the efficiency stage in which the project and the profits are consolidated and finally the fourth stage of growth or expansion.

3. The start-up ecosystem

The entrepreneurship ecosystem is the set of entrepreneurs who seek to develop new companies and for this purpose establishes diverse links in their academic, business, social, political and economic environments (Fetters, Greene, Rice, & Butler, 2010). The entrepreneurship ecosystem of the start-ups is composed of a community of technology-based entrepreneurs, their leaders and facilitators who support this community such as universities, government, investors, service providers and other stakeholders (Feld, 2012). A start-up is a type of company with a high level of projection of growth due to the intensive use of the technology in its construction and development, whose main objective is to innovate in products or services for its clients (UNAM, 2013).

In the provision of services to new enterprises, the incubator is a physical space usually linked to a knowledge center (university, research institute, business school, etc.) and through this, spinouts and business ideas are supported by in exchange for a monthly fee or some type of future remuneration. This provides physical offices, mentoring, consultancy, training programs, and linkage with public and private investors, among other services (Salido, Sabás, & Freixas, 2013). An extension of the incubation of companies is the accelerator which is a model that became known with the Y-Combinator in the USA, and it has spread all over the world. It is characterized by having an open application process and usually has pre-seed investments in exchange for a stake in the start-up property, has a limited time, offers intensive tutoring and is grouped in new ventures that start simultaneously (Salido, Sabás, & Freixas, 2013).

In the area of financing are located angel investors who are legal or natural persons with business experience and who are interested in participating in new ventures. The mechanism consists in financing companies with capital in the initial stages, focusing their decision to finance one or another company in the business plans. The main difference between angel investors and venture capitalists is those angels use their own funds to invest (Ayala & González, 2010).

According to Feld (2012), the basis to be effective for an entrepreneurial ecosystem is that certain conditions are met:

- The most experienced entrepreneurs must lead the entrepreneurial community.
- Facilitators can lead the support to the entrepreneurial ecosystem but not create or lead the ecosystem.
- The commitment of leaders should be long-term (several years).
- Mentorship and collaborative participation must exist.
- There must be continuous events for the entire entrepreneurial community, networking and feeling of belonging to community are important.
- There must also be willingness to experiment, risk and fail quickly, as these allow the entrepreneurship to evolve.
- The entrepreneur community must be open to new members regardless of their origin.
- There must be a high density of entrepreneurs and quality of life conditions.
- There is a need for start-ups to resort to self-financing at the beginning of the ecosystem, until there is more closeness between entrepreneurs and investors.
- There is a need for an attitude of detachment from the community to help other members.

In addition, the interaction of entrepreneurs with the business community and the development of networks are important (Kerrick, Cumberland, Church-Nally, & Kemelgor, 2014).

4. Analysis of interorganizational networks

The analysis of interorganizational networks is based on the social networks analysis, where the nodes of the network are the organizations or entities.

Social networks have existed with the interaction between people, that is, since the beginning of humanity, this interaction has immediate and future consequences in their lives, these can be fatal or positive, as one is responsible for shaping the network, and we are partly responsible for these consequences. When studying social

networks, it is possible to determine which individuals are most active and which interactions are stronger, because individuals can belong to different networks and in each network; the organization will be different according to the interaction that is required by the objectives of the network. These interactions follow certain rules that allow identifying how the activity occurs among the members of the network (Christakis & Fowler, 2009).

According to Kadushin (2013) the term networking is used on a daily basis and may be thought to exist with Internet, but in reality Internet is just another way of communicating and has made possible to refer to social networks in a systematic way. Being immersed in social networks cannot let see details that it is possible to see with the analysis of these networks.

The most important points of the network analysis are: connections, networks as information maps, leaders and followers, and networks as conduits, as detailed below (Kadushin, 2013):

- The connections you have with online sites are important for networking because you can reach a very high number of users. Users of social networks hope that these connections can be useful, for example to find employment.
- The social networks analysis allows you to see what cannot be directly observed, the use of this information can be used in different fields such as marketing to influence the purchase of products. Also in applications from different fields such as legal and security.
- Intermediation for leaders' followers through Web services is important, although in the event that they fail and have problems they would affect the networks that depend on these services, as in the case of electricity networks, the failure of one of the components can cause the entire network to fall. In the case of people who have certain characteristics, will cause them to look for people of the same affiliation called homophily. So persuading in that network will be very easy: like viral marketing, although sometimes it might not work.
- Connections are consequences of behavior, and ideas are shared through those relationships and ideas will become similar. Human networks can also be analyzed structurally and there is feedback between structure and behavior.

The following are the most important concepts in the social network analysis (Wasserman & Faust, 2013):

- **The actor:** the actors or nodes are individual, corporate or collective discrete social units.
- **The relational link:** actors are related or connected to each other through social ties or connections: they can be evaluation (such as friendship and pleasure), transference (such as loan, sale), affiliation, behavioral interaction, etc.
- The dyad: it is the bond that is established between two actors through a link between them.
- The triad: it is a subset of three actors and the links between them.
- The subgroup: any subset of actors and the links between them.
- The group: it is a collection of all the actors whose ties must be measured.
- The relationship: is the collection of links of a specific type among the members of a group.
- The social network: is a set of several finite sets of actors and the relationship or relationships defined between them.

The data used to analyze social networks are as follows (Wasserman & Faust, 2013):

- **Structural variables:** the bonds of some kind between pairs of actors.
- **Composition variables:** they are the attributes of the actors.
- Mode: is the distinctive set of entities in which variables are measured.

At the discretion of the researcher, this should identify the population that is formed by the actors or social units to which the measures would be taken and in case it cannot be measured in its entirety, it must find the mechanisms to take a sample (Wasserman & Faust, 2013).

When performing social network analysis measurements are taken based on the statistical and matrix theory (Wasserman & Faust, 2013; UNS, 2016):

a. **Centralization indexes:** These are measures that allow comparing in what magnitude a network is organized around a central point or zone.

b. **Degree, Centrality Degree:** It is the measurement of the number of nodes with which each actor is connected, this value is an indicator of the influence of the actor in the network.

c. **Betweenness Centrality:** It is the measure of the dependency that the actors have of the focal nodes to make their contacts.

d. **Closeness Centrality:** The radial length measurement that calculates the average of the shorter geodetic distances of the actors towards all the others.

e. **Density:** It is the measure of the number of existing links in relation to the number of possible links.

f. **Reciprocity:** It is the measure of the number of links involving mutual dyadic interactions on the total of links.

g. **Eccentricity:** The eccentricity of a node is the longest path from that node to any other node in the network. A path is any path between two nodes where no node is visited more than once. Nodes with less eccentricity are more central by this measure.

h. **Eigen centrality:** In this measure the most central actors are identified in terms of the global structure of the network, leaving aside the more local patterns.

i. **Clustering:** It is an index that indicates the level of grouping of an actor with its neighboring nodes, a coefficient of high grouping indicates that it is closely related to neighbors, whereas a low coefficient indicates the opposite.

j. **Modularity Class:** Modularity is a measure of the structure of networks or graphs. It was designed to measure the strength of the division of a network into modules (also called groups, grouping or communities)

k. **Harmonic Closeness Centrality:** It is a measure of centrality focused on the transfer of information, indicates the degree of connection with other nodes through short paths (Rochat, 2009).

One of the most important social networks on the Internet is LinkedIn, which connects professionals from around the world with more than 430 million members, including Fortune 500 executives; LinkedIn is the world's largest professional network on the Internet. The company has a diversified business model; its revenues come from talent solutions, marketing solutions and premium subscription products. It is based in Silicon Valley and has offices in different countries (LinkedIn Corporation, 2016b).

5. Methodology

In this study a quantitative-qualitative research design is used (Hernández, Fernández, & Baptista, 2010), quantitative by the determination of the social network indicators and qualitative due to the revision of records and attributes that allow to give an interpretation of these indicators, in the social network analysis these methods are complementary (Edwards, 2010). The data of the relationships between the actors are collected directly from an Internet social network, LinkedIn, data allows making the analysis about the state and characteristics of the technological entrepreneurship ecosystem in the city of Lima, and in this case the situation will be investigated through network measurements.

Using the social networks analysis it will determine the indexes between the different elements of the technological entrepreneurship ecosystem in Lima: the community of entrepreneurs, mentors, incubators, accelerators, common service providers, angel investors, venture investors, universities, public support entities and linkages with other ecosystems.

5.1 Obtaining and pre-processing network data

For this study we obtained the data of the contacts of Linkedin of one of the authors, who registered during three years of an active participation in the entrepreneurial ecosystem of Lima including diverse actors of this system. In this way, this network of contacts represents a sample of that ecosystem and the interactions within this interorganizational network. The procedure applied was as follows:

a. An application was implemented with scripts in PHP and JavaScript for LinkedIn's API (Application Programming Interface) (LinkedIn Corporation, 2016c) to obtain node information automatically. In order to use the application, the registration was done on LinkedIn, the new application was first configured on the application registration page and an authorization code was requested for it. This enabled you to initiate a user session to obtain an access authorization code to perform authenticated data requests (LinkedIn Corporation, 2016a). The user must have among his contacts, actors of the network to be studied.

b. The application was developed to perform the requests for downloading the data of contacts, the data to be considered for the study are the links between the contacts, the entity to which they are related, the industrial sector to which they belong, the city, the country And the job title. Pre-processing of the downloaded data has been done through the text editor Notepad++ and the spreadsheet program, Excel. Scripts in PHP and JavaScript were developed in the text editor and those in R using RStudio.

c. On the basis of the data considered, the elements identified were the founders of start-ups, mentors, representatives of accelerators, incubators and companies that provide services to start-ups, investors, representatives of universities and public institutions related to the ecosystem.

d. In the resulting network, the nodes are start-ups (STUP), mentors (MENT), incubators (INCU), accelerators (ACCE), common service providers (SERV), angel and venture investors (INVR), universities (UNIV) and public institutions (PUBL). The nomenclature in parentheses will be used in the presentation of the network diagrams and the tables of the results.

e. Numeric labels were assigned to the nodes for social network analysis.

5.2 Measurements of the social network and elaboration of the network diagrams

For this study measurements of the network were made using software for this purpose UCINET, GEPHI and R on pre-processed data.

The data on the actors are used to create network diagrams using nodes and arrows; these allow visualizing the relationships between the actors of the ecosystem. The diagram can let us see the flow of financing, services, mentoring or information between different elements of the network.

5.3 Identification of the central entities, subgroups in the network

The network diagrams allow identifying which entities are the most important within the network or a group, as well as the centrality indexes found, for example a high degree of centrality indicates the leadership or the influence of an actor in the network or in its subgroup.

Subgroups in a network are presented because of location, function, activity, influence, dependency, among other characteristics with the other actors.

5.4 Criteria for interpreting results

In this case, the presence or absence of elements of the entrepreneurship ecosystem and the influence of the elements in the interorganizational network described in the revised literature will be verified. Reviewing the records and attributes of actors and the ecosystem allows interpreting and understanding the results.

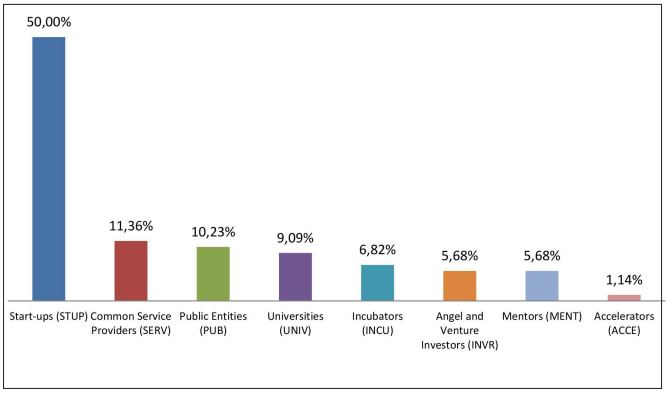
6. Results, analysis and discussion of results

First the results were analyzed considering an interorganizational network with only the nodes of Lima and then considering additionally the nodes of other countries.

6.1 Results of the interorganizational network with only Lima nodes

Figure1 shows the presence of the different elements in the Lima ecosystem: entrepreneurs (start-ups), mentors, incubators, accelerators, common service providers, angel investors, venture capital investors, universities and public support entities. In the case of the accelerators only the presence of an organization of this type is evidenced. Of a total of 88 nodes, 50% are Start-ups (STUP), 11.36% are Common Service Providers (SERV), 10.23% are Public Entities (PUB), 9.09% are universities, 6.86% are incubators (INCU), 5.68 % Are angel investors and risk investors (INVR), 5.68% are mentors (MENT), 1.14% of Accelerators (ACCE). It is also observed that start-ups and mentors (community of entrepreneurs) together constitute the largest percentage of entities in the network.

Figure 1. Distribution of the organizations in the network of Lima

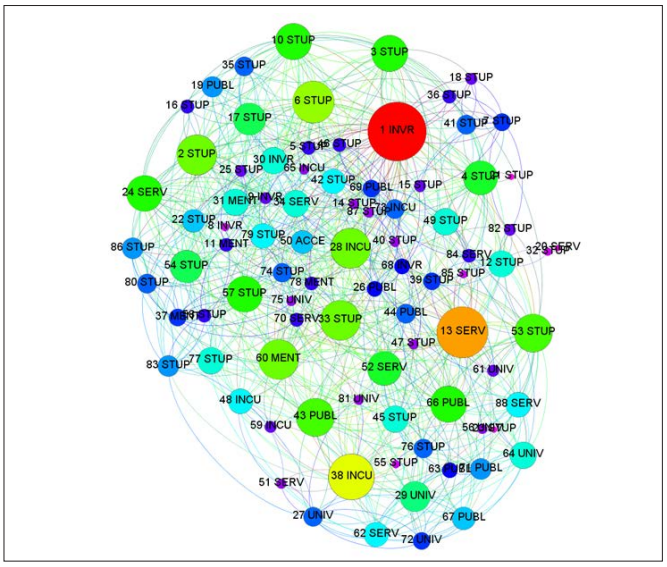


Source: Prepared by the authors

Figure 2 shows the interorganizational network, which has 88 nodes of Lima and 814 links, corresponding to a density of 10.6% and to link two organizations without direct link, in the worst case it should be done using 6 links in the network, so the network has a diameter of 6 and an average degree of centrality of 18.5. The nomenclature used is the node number followed by the category of the entity, for example node 1 is an investor, so it is labeled 1 INVR. The color and size indicate the degree of influence, the greater the size, the greater influence, and the colors ordered from greater to lesser influence are: red, orange, yellow, green, sky blue, purple and pink.

Figure 2 and the *Table 1* show the influence of the nodes on the network (lists of highest to least degree of influence in each category): of the accelerator, node 50, incubators, nodes 38, 28, and 48, of the investors, nodes 1, 30, and 68, of the mentors, nodes 60, 31 and 37, of the public entities, nodes 43, 66 and 67, of the common service providers, modes 13, 24 and 52, of the start-ups, nodes 6, 33, 2, 53, 3, 10, and 57, of the investor, node 1, of the service provider, node 13 and of the incubator, node 38. The indices indicate a high centrality of the investor 1 INVR, The incubator 38 INCU, the most connected actors, have greater influence, are intermediaries among other actors, have greater proximity to other nodes and are connected to the closest entities.

Figure 2. Interorganizational Network with only nodes of Lima



Source: Prepared by the authors

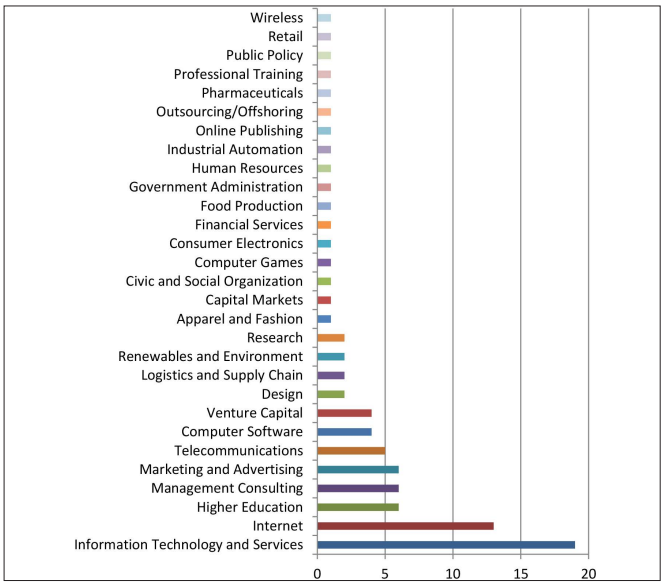
Figure 3 and Figure 4 show that ecosystem entities are most active in the information technology services sectors, followed by the Internet, Marketing and Advertising and Management sectors.

Table 1. Organizations with higher indexes of centrality in the network of Lima

Id	Category	Degree	Eccentricity	Closeness Centrality	Harmonic Closeness Centrality	Betweenness Centrality	Clustering	Eigen Centrality
50	Accelerator	20	4	0.46	0.51	83.42	0.311	0.404
38	Incubator	44	4	0.50	0.59	628.35	0.173	0.612
28	Incubator	38	4	0.53	0.59	205.37	0.298	0.806
48	Incubator	22	4	0.47	0.52	138.97	0.273	0.467
1	Investor	58	3	0.58	0.66	828.68	0.182	1.000
30	Investor	24	4	0.47	0.52	71.73	0.424	0.505
68	Investor	12	4	0.44	0.47	66.34	0.067	0.193
60	Mentor	38	4	0.51	0.58	326.13	0.211	0.672
31	Mentor	24	4	0.47	0.53	88.18	0.258	0.487
37	Mentor	14	5	0.40	0.44	17.58	0.286	0.225
43	Public Entity	36	3	0.53	0.59	276.83	0.222	0.716
66	Public Entity	34	3	0.50	0.56	261.05	0.272	0.631
67	Public Entity	20	4	0.45	0.50	34.05	0.511	0.386
13	Com. Ser. Provider	50	4	0.55	0.63	571.70	0.230	0.913
24	Com. Ser. Provider	34	4	0.48	0.56	229.79	0.110	0.517
52	Com. Ser. Provider	32	3	0.51	0.57	333.04	0.200	0.524
6	Start-up	40	3	0.52	0.59	353.50	0.253	0.757
33	Start-up	38	4	0.52	0.59	347.66	0.211	0.710
2	Start-up	38	4	0.51	0.58	365.13	0.135	0.595
53	Start-up	36	4	0.51	0.58	491.36	0.163	0.603
3	Start-up	34	4	0.49	0.56	267.25	0.243	0.607
10	Start-up	34	4	0.50	0.57	164.92	0.324	0.637
29	University	28	4	0.47	0.53	148.49	0.275	0.440
64	University	24	4	0.46	0.51	79.91	0.394	0.428
27	University	16	4	0.38	0.44	48.88	0.214	0.205

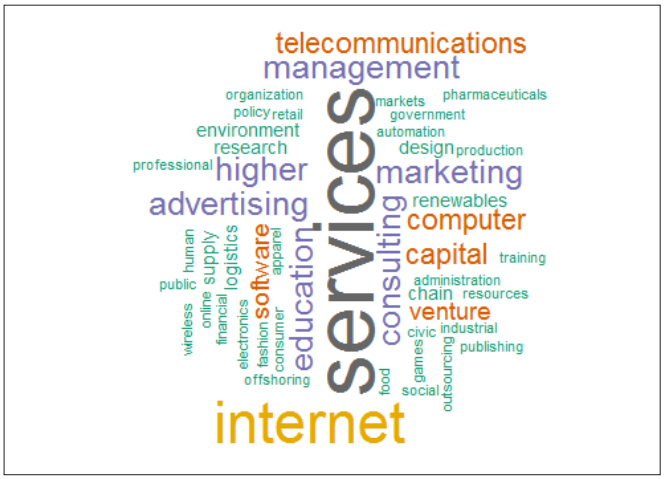
Source: Prepared by the authors

Figure 3. Distribution in the industrial sectors of the Lima network



Source: Prepared by the authors

Figure 4. *Cloud of the industrial sectors of the Lima network*



Source: Prepared by the authors

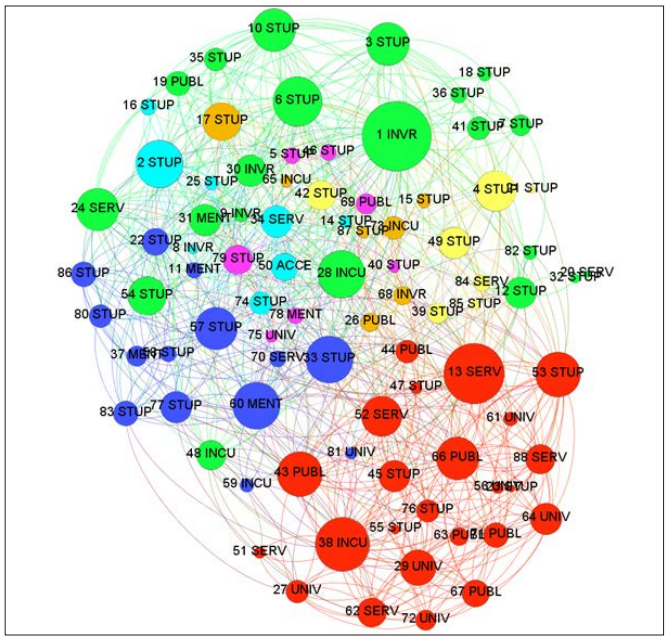
Table 2 shows 7 subgroups identified in the analyzed network and *Figure 5* shows that the leadership of the start-ups in the ecosystem is evident, due to its high indexes of centrality of these are presented in the different subgroups. Except for subgroup 6, which is formed mainly by universities and governmental organizations, which shows a high link between these entities, but the lack of integration with a greater number of start-ups in the Lima ecosystem by these entities, except for The incubators of the universities that have activity in other subgroups, which evidences the governmental intervention in the ecosystem, now with a fourth generation of 69 Start Up Peru ventures that are incubated (PRODUCE, 2016). Subgroup 2 is formed by start-ups and a service provider, which shows that start-ups in the ecosystem do not have a high link with other types of organizations and this may be due to the fact that they are in the early stages, nature of the sector of the start-ups or the ecosystem is in process of maturing.

Table 2. Members of the subgroups in the interorganizational network of Lima

Subgroup	Members of the subgroup	Organizations with greater centrality
0 (Light blue)	50 ACCEL 8 INVR 34 SERV 2 STUP, 14 STUP, 16 STUP, 25 STUP, 74 STUP	2 STUP 34 SERV 50 ACCEL
1 (Green)	28 INCU, 48 INCU 1 INVR, 9 INVR, 30 INVR 31 MENT 19 PUBL 20 SERV, 24 SERV, 3 STUP, 6 STUP, 7 STUP, 10 STUP, 12 STUP, 18 STUP, 32 STUP, 35 STUP, 36 STUP, 41 STUP, 54 STUP, 82 STUP	1 INVR 6 STUP 28 INCU
2 (Yellow)	84 SERV 4 STUP, 21 STUP, 39 STUP, 42 STUP, 49 STUP, 85 STUP	4 STUP 49 STUP 42 STUP
3 (Orange)	65 INCU, 73 INCU 68 INVR 26 PUBL 15 STUP, 17 STUP, 87 STUP	17 STUP 73 INCU 26 PUBL
4 (Pink)	78 MENT 69 PUBL 5 STUP, 40 STUP, 46 STUP, 79 STUP 75 UNIV	79 STUP 69 PUBL 5 STUP
5 (Blue)	59 INCU 11 MENT, 37 MENT, 60 MENT 70 SERV 22 STUP, 33 STUP, 57 STUP, 58 STUP, 77 STUP, 80 STUP, 83 STUP, 86 STUP 81 UNIV	33 STUP 60 MENT 57 STUP
6 (Red)	38 INCU 43 PUBL, 44 PUBL, 63 PUBL, 66 PUBL, 67 PUBL, 71 PUBL 13 SERV, 51 SERV, 52 SERV, 62 SERV, 88 SERV 23 STUP, 45 STUP, 47 STUP, 53 STUP, 55 STUP, 76 STUP 27 UNIV, 29 UNIV, 56 UNIV, 61 UNIV, 64 UNIV, 72 UNIV	13 SERV 38 INCU 43 PUBL

Source: Prepared by the authors

Figure 5. Subgroups in the interorganizational network of Lima

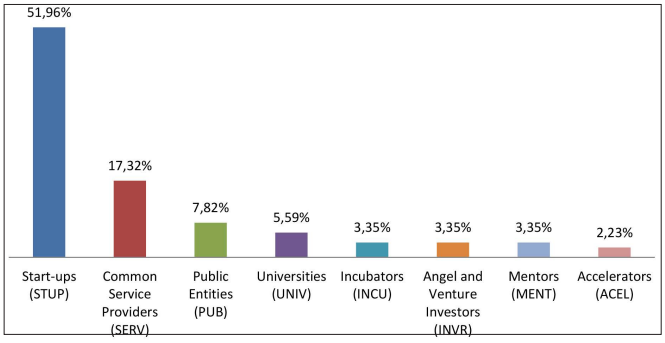


Source: Prepared by the authors

6.2 Results of the interorganizational network including foreign nodes

Similar to the network with only nodes of Lima, *Figure 6* shows the presence of the different elements in the ecosystem, of the 179 nodes, 51.96% are Start-ups (STUP), 17.32% are service providers (PUB), 5.59% are universities, 3.35% are incubators (INCU), 3.35% are angel investors and risk investors (INVR), 3.35% are mentors (MENT), 2.23% Accelerators (ACCEL). It is observed that the start-ups and the mentors (the community of entrepreneurs) together constitute the greater percentage of entities in the network. The distribution of organizations is similar to the network in which only the nodes of Lima were considered.

Figure 6. Distribution of organizations in the network with foreign nodes

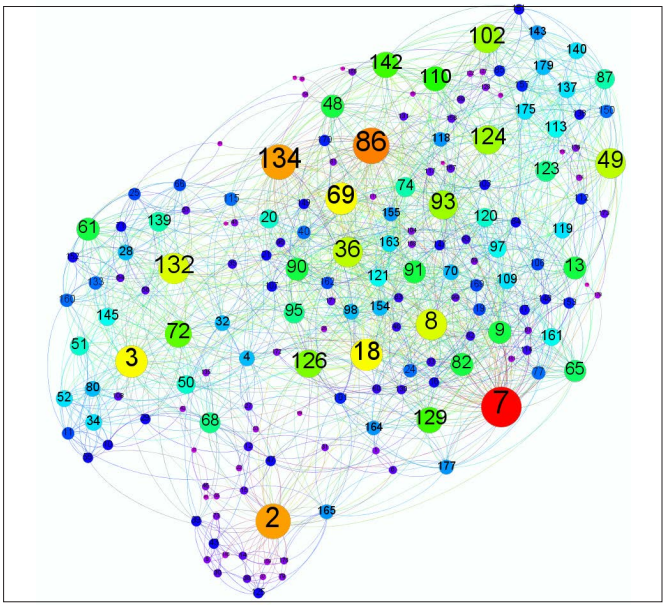


Source: Prepared by the authors

Figure 7 shows the interorganizational network with 179 nodes of Lima and the world and 1768 links, which correspond to a density of 5.5% and to link two organizations without direct bond, in the worst case it should be used Of 6 links present in the network, so the network has a diameter of 6 and an average degree of centrality of 19.75.

For the nomenclature in the network diagrams, the nodes with the corresponding number have been labeled. The color and size indicate the degree of influence, the greater the size, the greater the influence, and the colors ordered from greater to lesser influence are: red, orange, yellow, light green, green, sky blue, purple and pink.

Figure 7. Interorganizational network with foreign nodes



Source: Prepared by the authors

Figure 7 shows the influence of nodes from different countries on the network, accelerators from Peru, Chile and USA, incubators from Peru, investors from Peru, USA, Argentina and Chile, mentors from Peru, public entities from Peru and Chile, common service providers from Peru, start-ups from Peru, USA and Argentina, and Universities from Chile, Peru, Australia and Brazil. In this network also the indexes indicate a high centrality of the investors, they are the most connected actors and intermediaries among other nodes, and have more influence and more proximity to other entities.

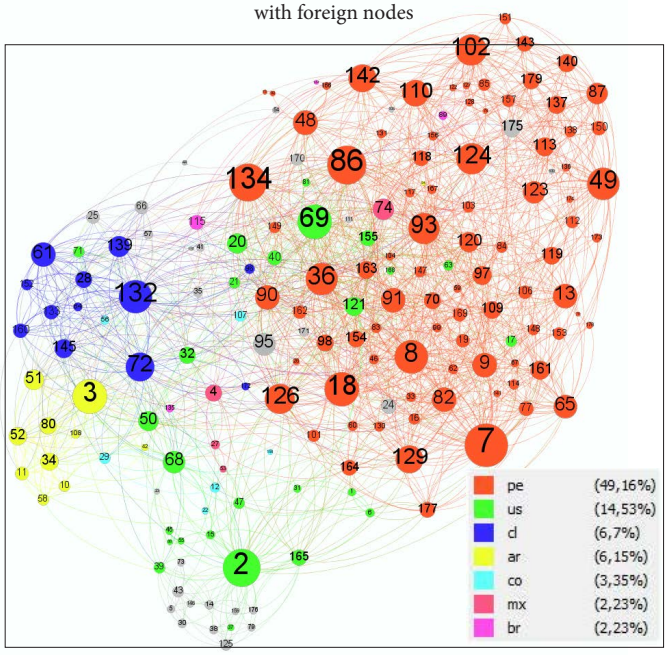
Table 3. Organizations with higher indexes of centrality in the network with foreign nodes

Id	Category	Country	Degree	Eccentricity	Closeness Centrality	Harmonic Closeness Centrality	Betweenness Centrality	Clustering	Eigen Centrality
120	Accelerator	Peru	30	5	0.40	0.45	261.30	0.248	0.439
145	Accelerator	Chile	28	4	0.42	0.47	307.03	0.429	0.368
1	Accelerator	USA	8	5	0.31	0.33	36.86	0.000	0.034
86	Incubator	Peru	64	4	0.47	0.54	1174.68	0.196	0.922
102	Incubator	Peru	50	4	0.42	0.49	1169.29	0.163	0.439
118	Incubator	Peru	22	4	0.41	0.45	239.43	0.273	0.384
7	Investor	Peru	72	4	0.48	0.56	1841.10	0.167	1.000
2	Investor	USA	62	4	0.46	0.53	4845.26	0.086	0.432
3	Investor	Argentina	56	4	0.43	0.50	1490.91	0.164	0.446
132	Investor	Chile	54	4	0.45	0.51	1378.85	0.199	0.621
134	Mentor	Peru	62	4	0.48	0.54	1780.52	0.161	0.823
91	Mentor	Peru	38	4	0.47	0.51	713.26	0.205	0.598
162	Mentor	Peru	18	4	0.39	0.43	69.90	0.333	0.296
142	Public Entity	Peru	44	4	0.44	0.50	1125.71	0.186	0.540
110	Public Entity	Peru	42	4	0.47	0.52	1003.12	0.176	0.616
70	Public Entity	Peru	24	4	0.41	0.46	206.80	0.258	0.414
28	Public Entity	Chile	24	5	0.38	0.43	202.02	0.303	0.241
49	Com. Ser. Provider	Peru	52	4	0.45	0.51	1052.26	0.237	0.732
82	Com. Ser. Provider	Peru	38	4	0.42	0.48	405.13	0.135	0.492
123	Com. Ser. Provider	Peru	34	4	0.42	0.47	487.63	0.213	0.386
18	Start-up	Peru	56	4	0.47	0.53	1244.20	0.217	0.847
69	Start-up	USA	56	4	0.47	0.53	719.74	0.267	0.926
8	Start-up	Peru	54	4	0.46	0.52	1022.89	0.137	0.700
36	Start-up	Peru	52	3	0.49	0.54	1451.06	0.243	0.810
93	Start-up	Peru	50	4	0.46	0.52	959.55	0.187	0.729
94	Start-up	Argentina	2	6	0.26	0.28	0.00	0.000	0.008
72	University	Chile	46	4	0.42	0.49	931.60	0.217	0.490
87	University	Peru	32	4	0.40	0.45	262.34	0.283	0.334
140	University	Peru	26	5	0.39	0.44	178.45	0.385	0.311
175	University	Australia	26	5	0.37	0.43	668.26	0.244	0.235
85	University	Peru	16	5	0.34	0.38	94.66	0.214	0.132
151	University	Peru	14	5	0.35	0.39	13.33	0.619	0.169
89	University	Brazil	10	5	0.33	0.37	66.48	0.300	0.080

Source: Prepared by the authors

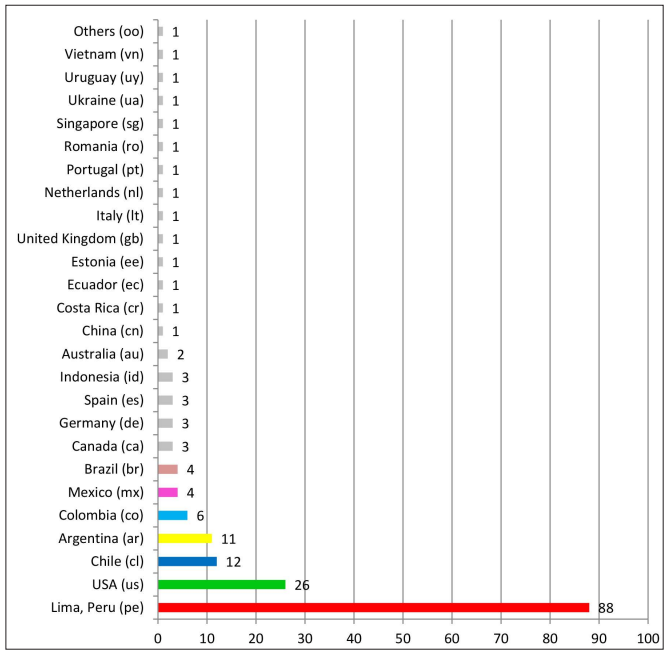
Figure 8 and *Figure 9* show that the ecosystems of USA (us), Chile (cl), Argentina (ar), Colombia (co), Mexico (mx) and Brazil (br) are the most influential in the start-up ecosystem of Lima in this order, but in addition there is evidence of linkage with ecosystems of Canada (ca), Germany (de), Spain (es), Indonesia (id), Australia (au), China (cn), Costa Rica (cr), Ecuador(ec), Estonia (ee), United Kingdom (gb), Italy (it), Netherlands (nl), Portugal (pt), Romania (ro), Singapore (sg), Ukraine (ua), Uruguay (uy) y Vietnam (vn).

Figure 8. Distribution of the organizations by country in the network with foreign nodes



Source: Prepared by the authors

Figure 9. Actors by country in the interorganizational network



Source: Prepared by the authors

Table 4, *Table 5*, and *Figure 10* show 4 subgroups, in which the overall leadership of the start-ups in the ecosystem is evident, and in addition a high influence of the investors is observed because of their high centrality in different subgroups, except in subgroup 3 which is mainly composed of universities, government organizations and common service providers. This shows the high link between these last entities, similar to the local network analyzed, and also the lack of integration of them with a greater number of start-ups of the Lima ecosystem. On the other hand, the incubators appear linked to all the types of elements of the ecosystem. In *Table 4* and *Table 5* we use as nomenclature the node number followed by the category of the entity and the country code for example node 1 is an Accelerator from USA, so the node is labeled 1 ACCEL us.

Table 4. Subgroups in interorganizational network with foreign nodes

Subgroup	Members of subgroup
0 (Green)	2 ACCEL us 126 INVR us, 129 INVR us, 82 INVR de, 161 INVR us, 164 INVR us, 177 INVR ro, 165 INVR ee, 77 INVR us, 169 INVR vn, 101 INVR sg, 43 INVR us, 125 INVR au 39 MENT pe, 47 MENT pe, 12 MENT us 46 SERV pe 130 STUP pe, 38 STUP pe, 14 STUP pe, 30 STUP pe, 6 STUP pe, 15 STUP pe, 41 STUP pe, 73 STUP de, 176 STUP co, 5 STUP pe, 1 STUP de, 31 STUP id, 45 STUP us, 79 STUP ec, 22 STUP id, 159 STUP lt, 174 STUP co, 146 STUP id, 37 STUP pe, 55 STUP ua, 100 STUP us, 23 STUP us, 88 STUP ca 116 UNIV us
1 (Red)	3 ACCEL cl 132 INVR ar, 72 INVR cl, 61 INVR cl, 68 INVR cl, 139 INVR us, 51 INVR ar, 50 INVR ca, 145 INVR cr, 34 INVR nl, 52 INVR ar, 80 INVR co, 28 INVR uy, 4 INVR br 32 PUBL cl 115 SERV cl, 133 SERV cl 160 STUP us, 11 STUP ar, 66 STUP us, 25 STUP ar, 10 STUP ar, 58 STUP ar, 152 STUP mx, 29 STUP br, 107 STUP cl, 71 STUP cl, 96 STUP ar, 35 STUP ar, 108 STUP co, 64 STUP co, 56 STUP us, 27 STUP cl, 57 STUP mx, 135 STUP cl, 172 STUP ar, 42 STUP mx 53 UNIV cl
2 (Blue)	7 ACCEL pe 86 INCU pe, 134 INCU pe, 18 INCU pe, 69 INCU pe, 8 INCU pe 36 INVR pe, 93 INVR pe, 9 INVR us, 13 INVR pe, 48 INVR pe, 90 INVR pe 91 MENT pe, 65 MENT pe, 95 MENT pe 120 PUBL pe, 20 PUBL pe 97 SERV pe, 121 SERV pe, 109 SERV us, 119 SERV es, 163 SERV pe 70 STUP pe, 98 STUP us, 154 STUP pe, 118 STUP pe, 155 STUP pe, 24 STUP pe, 40 STUP pe, 19 STUP pe, 106 STUP pe, 162 STUP es, 170 STUP us, 153 STUP us, 16 STUP pe, 103 STUP pe, 147 STUP pe, 148 STUP pe, 149 STUP pe, 17 STUP us, 21 STUP oo, 33 STUP pe, 60 STUP pe, 62 STUP gb, 83 STUP pe, 114 STUP pe, 63 STUP us, 171 STUP us, 99 STUP pe, 117 STUP pe, 131 STUP pe, 167 STUP pe, 59 STUP ca, 67 STUP pe, 104 STUP pe, 81 STUP pe, 168 STUP pe, 111 STUP pe, 26 STUP pe, 141 STUP us, 178 STUP cn, 158 STUP pe, 44 STUP co, 92 STUP pe, 94 STUP ar, 75 STUP pe 76 UNIV us
3 (Yellow)	49 ACCEL pt 102 INCU pe 124 PUBL pe, 142 PUBL pe, 110 PUBL pe, 123 PUBL pe, 74 PUBL pe, 87 PUBL pe, 113 PUBL pe 175 SERV pe, 137 SERV pe, 140 SERV pe, 179 SERV pe, 143 SERV pe, 150 SERV pe 85 STUP pe, 112 STUP mx, 157 STUP pe, 84 STUP pe, 138 STUP pe, 151 STUP pe 89 UNIV pe, 156 UNIV au, 173 UNIV pe, 128 UNIV pe, 136 UNIV pe, 166 UNIV br, 54 UNIV pe, 122 UNIV pe, 127 UNIV pe, 78 UNIV pe, 105 UNIV es 144 UNIV br

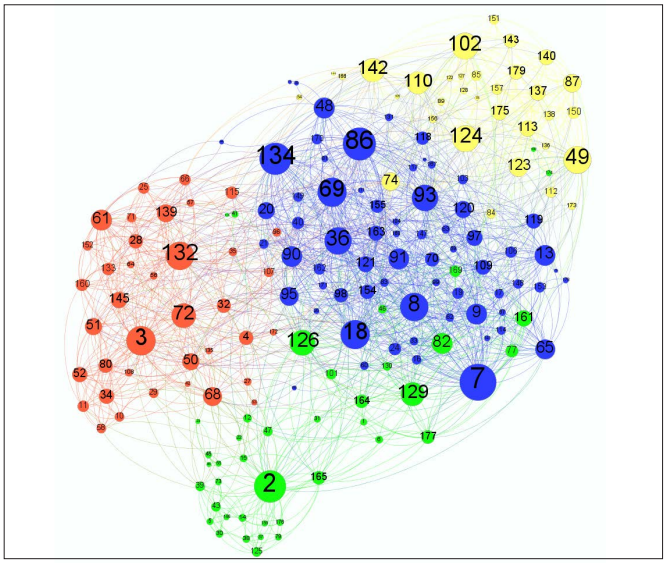
Source: Prepared by the authors

Table 5. Countries with more presence and more influential organizations in Subgroups

Subgroup	Countries with more presence	Organizations with greater centrality index
0 (Green)	Peru, USA y Germany	2 INVR us 126 STUP pe 129 STUP pe 82 SERV pe 161 STUP pe
1 (Red)	Chile, Argentina and USA	3 INVR ar 132 INVR cl 72 UNIV cl 61 INVR cl 68 STUP us
2 (Blue)	Peru and USA	7 INVR pe 86 INCU pe 134 MENT pe 18 STUP pe 69 STUP us
3 (Yellow)	Peru and Brazil	49 SERV pe 102 INCU pe 124 STUP pe 142 PUBL pe 110 PUBL pe

Source: Prepared by the authors

Figure 10. Subgroups in the Interorganizational network with global nodes



Source: Prepared by the authors

Conclusions

According to the work carried out in the analysis of interorganizational networks, it is concluded that there is an ecosystem of technological entrepreneurship in Lima with the link between the different elements: the community of entrepreneurs, mentors, incubators, accelerators, service providers Common investors, angel investors, venture capital investors, universities, public support entities and linking with other ecosystems. In this ecosystem, start-ups and mentors (the community of entrepreneurs) constitute the largest percentage of entities in the network and generally have a presence and leadership in the ecosystem.

The indexes show a high centrality of the investors, being the most connected actors, who have more influence, who are intermediaries among other actors and who have more proximity to other nodes. Thus, investors are also actors who have a significant presence in the ecosystem. On the other hand, universities and public institutions have a high link between them, but in general they show a low integration with the start-ups of Lima ecosystem, except the incubators of the universities that they interact with the start-ups through Government programs for ecosystem development.

In particular, in Linkedin sectorial classification, the information technology, Internet, management and marketing, and advertising services sectors of the ecosystem are more active. This means that start-up activity is not developing at the same level in other emerging technologies such as new materials and biotechnology, among others, which requires a special public policy effort.

With respect to international connections, it is observed that the ecosystems of the USA, Chile, Argentina, Colombia, Mexico and Brazil are the ones that have the greatest linkage and therefore are the most influential in the technological entrepreneurship ecosystem of Lima. In addition, there is a smaller link with ecosystems in Canada, Germany, Spain, Indonesia, Australia, China, Costa Rica, Ecuador, Estonia, United Kingdom, Italy, Netherlands, Portugal, Romania, Singapore, Ukraine, Uruguay and Vietnam.

In the exploratory study (Hernández & González, 2016) and prior to this investigation was concluded that from the perspective of the entrepreneurs, there are all elements of the entrepreneurial ecosystem in the city of Lima, although the perception of these is completing, as the enterprise is advancing in its stages of development. In this study of analysis of interorganizational networks, it is corroborated that the entrepreneurial ecosystem of Lima presents these elements and it is

added that there is an intense interaction between them, which has developed in the city in recent years. However, as noted in the previous conclusions, there is still a need for greater interaction between some elements, mainly universities and public entities.

Finally, as future research, it is proposed that the knowledge of Lima's technological entrepreneurship ecosystem could be further expanded through surveys of a representative sample of the members of the entrepreneurs community, in order to understand in greater depth which facilitators and barriers that are presented for the development of this ecosystem. Also, other tools from different branches of science could be applied to analyze the ecosystem, its determinants and its impact, as is the case of this study where the social networks analysis, a tool from sociology has been applied.

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