TECHNOLOGICAL SURVEILLANCE COMPETENCES FOR ENTREPRENEURS: A KEY FACTOR TO BOOST THE NUMBER OF SCIENCE-BASED STARTUPS

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ABSTRACT

This article explores how the development of technological surveillance competences in entrepreneurs can foster the increase in number of startups based on hard sciences and disruptive technologies rather than internet-based applications in Argentina. This analysis was done from an empirical perspective, using secondary sources of information and interviews with experts of the Ministry of Science and Technology of Argentina, academic directors of entrepreneurial programs and entrepreneurs. The article is structured as follows: initially, a startup's database analysis was performed based on the report of Tecnolatinas Research and venture capital databases. As a result, emerged the low percentage of science- based startups in Argentina and Latin America compared with the internet-based ones. A list of the most relevant science-based startups from Argentina was developed.
Several factors emerged as possible contributors to the situation: i) level of interaction between Academia and entrepreneurs; ii) level of Technological Surveillance training of entrepreneurs; iii) level of Technology transference from Academia to entrepreneurial ecosystems and; iv) level of interdisciplinarity inside Academia. Among all of the surveyed factors, the level of Technology Surveillance training of entrepreneurs was considered very relevant for being considered strategic. A research of the main programs and courses about entrepreneurship in Argentina was conducted, showing the absence of the technological surveillance subject in almost all of them. Finally, a set of findings are discussed and presented together with potential areas for further considerations and implementation.
Keywords: technological surveillance competences, science-based startups, interdisciplinary education, innovation, start up's management

INTRODUCTION

Traditionally, the main adopted innovation processes have followed linear models. Within those known as first generation models, the "Technology Push Model" was the most widely used. This model involves different phases including scientific discovery, applied research and development (R&D), technological development and innovation.
From the mid 1960s to the early 1970s a second generation appeared, known as "Market Pull Models" that focus on the identification of the market's needs. These two approaches for innovation streams are characterized by a sequential order. The differences between the two approaches and the "tension" between them was analysed by Mike Volker (1988).
Innovation is not always fostered by R&D nor by market needs. Many times, innovation is driven by changes and contributions coming from other sources which play a role in

different phases of the process, which in many cases, is neither linear nor direct. As a result, another generation (the third) of nonlinear models appeared, such as, "The Linked-Chain Model" (Kline, 1985), "The Cycle Model" (Gomery, 1989), Alic-Branscomb's model (Alic et al, 1992), OECD's Oslo manual (OECD, 1991) and "The Neural Net Model" (Ziman, 1991) all of which included feedback in the innovation process.

A fourth generation of innovation models combines innovation process phases and feedback from the environment, and more recently, a new generation of models incorporates the "network concept" and an open innovation approach. More particularly in these new approaches, startups have an important role in cooperating with large organizations due to their innate innovative skills.

This paper highlights the situation of the "Market Pull Innovation Process" in the Argentinian market where there is a very low percentage of science-based startups[1] creation in comparison with the number of internet-based startups.

MATERIALS & METHODS

To guide the research, we consider three questions: What is the current situation in Argentina regarding science-based startup creation? What factors are influencing the current situation? And, what tools are available in Argentina to foster this type of startups? A first approach to the problem was conducted combining a bibliography search with semi-structured interviews performed to key informants. Primarily, to learn about the current situation many databases were analysed. For this purpose, the *Tecnolatinas* Radar Report (Surfing Tsunamis & NxtpLabs, 2016), many Argentinean publications related to the subject were scanned and summarized.

During the interviews, entrepreneurs were asked the following five questions

A) How would you rate the effectiveness of the Argentine National Innovation System in relation with innovative countries and other Latin American countries?

B) If you see differences in this previous assessment, what are in your opinion the factors that contribute to this situation?

C) Why do you consider that neither basic nor applied research rarely become a startup in Argentina?

D) Why are there only very few technology-based startups (other than IT and Internet-based) in Argentina?

E) Why Universities do not generate a considerable number of tech-based startups in Argentina?

It is considered that one of the factors of the deficiencies pointed out is the lack of technological surveillance. In 2006, when the UNE 1699006:2006 EX standard was first published, Technological Surveillance (TS) was defined as an "organized, selective and permanent process to get external information about technology, analyze and convert it into useful knowledge to decrease the risk on decision making and anticipate market changes (AENOR, 2006). Some examples of sources of information in the practice of TS are patents, utility models, trademarks and designs.

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[1] Startup: emerging company.

To determine the level of technological surveillance training available for entrepreneurs, a sample composed by a set of 24 courses/programs has been selected, taking into account the main locations where entrepreneurs' hubs are located: Buenos Aires City, Rosario, Santa Fe, Córdoba and Mendoza. Courses/programs selected are taught by different institutions like public and private universities, digital institutes, government agencies, entrepreneurship institutions, entrepreneurship foundations.

All 24 courses/programs were evaluated against inclusion criteria presented in Table 1.

Table 1
Technology Surveillance Concept Inclusion Criteria

Status	Criteria
No	When there are no Subjects nor Concepts of Technological Surveillance included in the Course/Program Curricula
Partially Included	When there are some Concepts of Technological Surveillance (a.e. patent management) included in the Course/Program Curricula
Yes	When there are Subjects and Concepts of Technology Surveillance in the Course/Program Curricula

RESULTS

What drives Innovation?

When considering what drives innovation, two extreme approaches are discussed as follows. The Technology Push approach presents some difficulties in the transferring of basic research results process to the market by scientists and technologists (Bozeman, 2000). And on the other hand, the Market Pull Innovation Model has difficulties in the technology acquisition process by entrepreneurs in order to design solutions to the market needs (Jones & Jain, 2002).

As the universe of companies is too diverse and heterogeneous, segmentation is required to understand the similarities among each particular group.

The first and most common segmentation is by size, there are pymes (*Resolución* N° 11, 2016) and large companies. Although this segmentation is useful mostly for financial, tax and credit purposes, there is another segmentation that is more useful regarding innovation. During the first stage of its development, ventures can adopt different configurations: entrepreneurial ventures, informal and formal startups or a new project inside an already established company. Regarding this first stage, according to statistics from Small Biz Trends only 3% of new startups make it to the 5th year in the US (Mansfield, 2016) and in Argentina the percentage is similar. Referring to startups Robehmed (2013) from Forbes magazine manifested that: "Those who sip the startup Kool-Aid define it as a culture and mentality of innovating on existing ideas to solve critical pain points".

Technological Surveillance Competences for Entrepreneurs

Mario Bunge – worldwide recognized Argentinian physicist, philosopher and epistemologist – defines pure or basic science as the foundation on which other sciences – the applied ones – are based (Alzugaray, Cruzado, Sinner Y & Salas, 2017).

Startups can be segmented into two groups according to its nature: i) science-based startups and ii) internet-based startups – also referred as "tech companies" like Facebook, Uber and Airbnb. For the purpose of this paper, only science-based startups will be discussed.

During this investigation, a new concept emerged, the "hybrid startups" that combines technological and computational knowledge (Campanario, 2016).

In Argentina, science – as the summation of pure and applied – is carried out in many prestigious organizations like *Instituto Nacional de Tecnología Agropecuaria* - INTA, *Instituto Nacional de Tecnología Industrial* – INTI, *Comision Nacional de Energía Atómic*a - CONEA and CONICET -*Consejo Nacional de Investigaciones Cientificas y Tecnologicas*- among others. CONICET for example has 9,236 researchers and 10,092 fellows (adding doctoral and postdoctoral scientists). Considering this, it would be probable to expect that "Technology Push" would be widespread and as a result of that, a large number of science-based startups across the country would be found. In order to test this hypothesis, the positioning of Argentina in the context of Latin America was explored.

The position of Argentina in the Latin America Innovation Ecosystem

According to a report presented annually by Cornell SC Johnson College of Business, INSTEAD (The Business School for the World™) and WIPO (World Intellectual Property Organization), Argentina ranked 76th in the Global Innovation Index 2017. The best ranked from the South American region was Chile ranked 46th followed by Mexico (58th), Uruguay (67th), Brazil (69th) and Peru (70th) (Cornell, INSTEAD, WIPO, 2017).

The financial valuation of a company is another way to segment companies' universe, and in the innovation ecosystem in particular, the *unicorns* – private companies valued at 1 billion American dollars or more – have a very significant place. When considering the nine *unicorns* from Latin America, four are from Argentina (Despegar.com, Globant, MercadoLibre y OLX), two are from Brazil (B2W y Totvs), two from Mexico (KIO Networks y Softtek) and one from Chile (Crystal Lagoons). None of the four Argentinian Unicorns, can be considered science-based. According to the book "*Argentina Innovadora*" [Innovative Argentina], the next candidate to become unicorn is Bioceres, a startup incubator (Estenssoro & Naishtat, 2017).

Moving down in the valuation ladder, "*Tecnolatinas* Radar Report" evaluated startups with a market value ranging from 25 million to more than 1 billion American dollars. It stated that from 123 startups analyzed in-depth from Latin America, only 3 of them were not based on internet developments (Surfing Tsunamis & NxtpLabs, 2016). Another analysis conducted by the authors over foundational startups data provided by Redpoint Ventures – a venture capital firm – revealed that there was only one science-based startup over 154 incubated[2] by the firm.

The next step was the search and analysis of companies valued in less than 25 million. During the research, it was found that there was not consolidated data base regarding

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[2] Further, more in-depth research should be developed over other venture capital data banks like Crunchbase, LAVCA, AngelList, Deal Books, Accel Partners, Redpoint Ventures and 500 startups.

startups within this valuation range. The information in this range is both disseminated and incomplete, making very difficult its systematic analysis and comprehension of the situation. Nevertheless, the research team was able to prepare a brief of the most relevant science-based startups from Argentina that is shown at Table 2.

Table 2
Most relevant science-based startups in Argentina

Name	Founder	Field	Sources
Argentum Texne	Research team from CONEA and Universidad de San Martin	Electronic noses for quality control and useful life of food and cosmetics	(Argentum Texne, 2018)
Auravant	Leandro Sabignoso (CEO), Nicolás Larrandart (CTO) and Leonardo Fernández (COO) (electronical engineers)	Agriculture of precision. Application that measures the amount of nitrogen necessary for seedtime.	(Auravant, 2018)
Bioceres	Los Grobo	We are a fully-integrated provider of crop productivity solutions, including seeds, seed traits, seed treatments, biologicals, high-value adjuvants and fertilizers. Unlike most industry participants that specialize in a single technology, chemistry, product, condition or stage of plant development, we have developed a multi-discipline and multi-product platform capable of providing solutions throughout the entire crop cycle, from pre-planting to transportation and storage	(Estenssoro & Naishtat, 2017)
Bioext	Hernan Farina (Bachelor en Biotechnology, Doctor in Basic and Applied Sciences)	Vegetal Biotechnology - Spin-off Universidad Nacional de Quilmes -	(Bioext, 2018)

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BioDrone	Luciana Bollati (Biologist, with Conicet doctoral scholarship).	Active pest control	(Cites, 2018)
Bioparx	Not disclosed.	Mio electrical prosthetics	(Bioparx, 2014)
Chemtest	Not disclosed.	Diagnosis of human and animal diseases using Elisa and LFIA	(Fan, 2018)
Clorar Ingeniería S.A.	Not disclosed.	Design of products and equipment for the chemical industry	(PTLC, 2018)
Don Mario	Alejandro Bartolome & Gerardo Bartolome	Seeds development	(Estenssoro & Naishtat, 2017)
EoloPharma	Pia Garat, Carlos Batthyány, Carlos Escande & Virginia López	New treatments of metabolic and cardiovascular diseases	(Cites, 2018)
iMvalv	Fabio Guarnieri	Ocular micro implant to avoid blindness	(Cites, 2018)
Incubatech S.A.	AMEGA Biotech	Production of active ingredients for medicines based on recombinant DNA	(PTLC, 2018)
Inmunova	Not disclosed. Spin-off - Instituto Leloir	Taylor made design of vaccines, antibodies and immunogenic agents	(Fan, 2018)
Invap	Conrado Varotto (physicist, entrepreneur and creator of INVAP)	Design and deployment of nuclear reactors for research, radars and satellites	(Estenssoro & Naishtat, 2017).
LIPOMIZE	Not disclosed.	Customized liposomal products	(Lipomize, 2018)
Mabb Biomaterial	Not disclosed.	Dental implants made of nanostructured ceramics	(CNTLZ, 2015)
Nanotica	Julio Laurenza (Bachelor in chemist)	Applied agro sciences - spin off of Nano encapsulation Laboratory of Moron University	(Laurenza, 2018)
Neogram	Camila Petignat (biologist)	Biotechnology to improve pastures	(La Nación, 2017)
Novartek	Not disclosed.	Machinery for the production of inoculation additives	(PTLC, 2018)
PB-L productos bio-logicos	Not disclosed. (spin off - Universidad Nacional de Quilmes)	DNA services	(Pb-l, 2018)

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Phylum Tech S.A.	Sergio Simonetta (Bachelor in Biotechnology, Doctor in Biological Sciences)	Creation of agile and effective solutions for the discovery of new drugs and molecules	(Estenssoro & Naishtat, 2017)
Rock River Laboratory	Not disclosed.	Animal diets formulation using 'near infrared spectroscopy' (NIRS)	(PTLC, 2018)
Satellogic	Emiliano Kargieman	Specialized in satellites, high-resolution real-time geo intelligence (La Nación, 2016)	(La Nación, 2016)
SEVER EBT	Not disclosed.	System for the early and remote diagnosis of acute coronary syndromes	(PTLC, 2018)
Thasa	Mario Mariscotti (Bachelor and Doctor in Physics)	Advanced technology for non-destructive inspection of reinforced concrete structures	(Mariscotti, 2018)
UnitecBlue	Not disclosed.	Smart cards for telephonic operators, and finance systems	(UnitecBlue, 2018)
Unleash	Daniel Katszman (MSc. Biochemistry)	Inmuno oncolytic. Virus that combats tumors.	(Estenssoro & Naishtat, 2017)
ViewMind	Matías Shulz (Engineer's degree)	Evaluation of cognitive abilities through the registration of eye movements	(Cites, 2018)
Zelltek S.A.	Not disclosed. (spin off - Facultad de Bioquímica y Ciencias Biológicas - Universidad Nacional del Litoral)	Complete process for obtain Recombinant Human Erythropoietin	(PTLC, 2018)

Preliminary conclusions: First, none of the science-based startups could not become 'Unicorns' yet. Second, the ratio between science-based and not-science-based is very small. and as result of that, it can be argued that still there is a lot of room to grow in the science-based field.

In the latest years, many NGOs emerged to foster the entrepreneurial environment, such as ASEA – Association of Entrepreneurs of Argentina, and several others promoted by the National Government with the aim to improve the startup's survival rate (ASEA, 2015).

Another type of companies, called accelerators, is part of the startup ecosystem and has emerged to provide resources to startups and improve the survival rates. Some iconic ones

in the science-based field are *Grid Exponencial*, *CITES*[3] (Iprof, 2017), and *Aceleradora Litoral* (Infobae, 2017).

Influential Factors in the Creation and Survival Rate of Science-based Startups in Argentina

As mentioned above, the number of science-based startups is lower than expected. Several factors emerged as possible contributors to the situation during the interviews: i) level of interaction between Academia and entrepreneurs; ii) level of Technological Surveillance training of entrepreneurs; iii) level of Technology transference from Academia to entrepreneurial ecosystems and iv) level of interdisciplinarity inside Academia.
In addition to the data gathered during the interviews, a bibliographic search was carried out to acknowledge other possible reasons not mentioned in the interviews. According to Doing Business index 2015, Argentina has several regulatory issues that prevent the startups from growing (Revilla, 2016). Among other obstacles, this publication mentions the lack of government support, underdevelopment of venture capital due to a combination of relatively low productivity, volatile exchange rate and high inflation expectations. Another factor is that scientists educated at the university are not trained in business, management, marketing or finance.

Technological Surveillance in the Science-based Startup Ecosystem

The strategic management of scientific and technological information is extremely important to innovate and survive in the actual complex and changing environment. In this context, the technological surveillance becomes an essential tool to detect opportunities of technological innovation and new ideas to facilitate improvements in processes, products and services in organizations.

Technological Surveillance practices are a key strategic factor to take advantage of the latest technological advances by entrepreneurs in order to develop innovative solutions to solve market needs identified by them.
So, entrepreneurs were asked: where do you go when you need to learn something related to business? A 100 % answered University Business Programs. The type of course they had attended ranged from non-graduate to Masters in Business Administration (MBAs) programs.
As University Business Programs are the most mentioned, the degree of implementation of TS in these program's curricula were measured. Table 3 shows the results obtained.

Table 3

Analysis of Technological Surveillance training at Argentine Entrepreneur Programs

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[3] CITES: Centro de Innovación Tecnológica, Empresarial y Social. Center for technological, business and social innovation.

Technological Surveillance Competences for Entrepreneurs

Institution	Type of Institution	Name of Course/Program	TSC included
FAUBA	Public University	Entrepreneur Training	NO
UBA (Capacitate)	Public University	Business startup for Entrepreneurs	NO
Fundación ITAU	Private Foundation	Free Course for Entrepreneurs	NO
INTI	National Agency	Scorecard for Entrepreneurs	NO
Municipalidad de Rosario	Municipal Agency	Rosario Emprende	NO
UNL	Public University	Summer Course for Entrepreneurs	NO
UP – CEDEX	Private University	Workshops for Entrepreneurs	NO
IAE	Private University	Programa IN	NO
UDESA	Private University	Pre-Entrepreneurs Program	NO
UTDT	Private University	Entrepreneurs Factory	NO
UTDT	Private University	Innovation Program	NO
UTDT	Private University	New Business Development Program	NO
UNGS	Public University	PRODEM – Entrepreneurs Development Program	NO
Digital House	Private Digital Institute	DIP – Digital Immersion Program	NO
Scalable	Private Institute	Entrepreneur Course	NO
Academia Argentina Emprende	Municipal Agency	Entrepreneur Program	NO
Endeavor	International Foundation	Entrepreneurs Program	NO
INICIA	Entrepreneurs Community	Entrepreneur Course	NO
USAM	Public University	Entrepreneur Training	NO

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ITBA	Private University	Entrepreneurs Training Program	NO
FCE UBA	Public University	Entrepreneurs Training Course	NO
PIPE	Private Foundation	Intensive Course for Entrepreneurs	Partially Included
UNTREF – CIDEM	Public University	Entrepreneurship Courses & Workshops	NO
UADE	Private University	Entrepreneurship Courses	NO
Results		Number of NO	23
		Number of Partially Included	1
		Number of YES	0

Typically, these courses include topics like entrepreneur profile, marketing, strategy, management skills, organization and human resources, operations, financial planning, legal and tax aspects and business plan definition.

But, although they have been designed specifically for entrepreneurs, almost none of these courses and programs (less than 1 in 24) include Technology Surveillance concepts as a subject in their curricula.

Tools and Programs that Foster Technological Surveillance in Argentina

Several programs and tools were available to entrepreneurs for filling the gap mentioned above. The main programs, mostly administered by *Ministerio de Ciencia, Tecnología e Innovación Productiva* and *Instituto Nacional de Propiedad Intelectual* are: i) VINTEC - National Program of Technological Surveillance and Competitive Intelligence (Mincyt, 2018); ii) Technological Antenna (Mincyt, 2018); iii) INPI *Patentes "Servicio de Información Tecnológica* [Service of Technological Information*]* (INPI, 2018); iv) UniMOOC - Technological Surveillance Course for Entrepreneurs (UniMooc, 2017) and v) OVTT[4] - Technological Surveillance and Competitive Intelligence Advanced Course (OVTT, 2018). More recent is the appearance of the "*Portal Argentino del Conocimiento Científico*" an open access to scientific libraries published at the webpage on *Ministerio de Ciencia, Tecnología e Innovación Productiva* (Mincyt, 2018).

Most of these tools and programs are being promoted in events organized by the same Agencies. Based on the comments of many of the interviewees: "Once you are in the Agency mailing list, you get access to all tools and programs". So that for entrepreneurs that are not on the list, there is little chance to obtain access to that information.

In the last two years, it was remarkable the change in the way the Agencies have modified its way to communicate, the advertisements are drafted in a more plane language. As it is

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[4] OVTT: Virtual Observatory for Technological Surveillance.

the case of the web page cited above, this page has four different users: i) scientists, researchers and institutions; ii) companies and entrepreneurs; iii) students and iv) people curious about science, and the language is appropriated for each of them (Mincyt, 2018). While an evolution towards the use of plane language and open access to data is appreciable, this effort is not good enough to deliver the message to a wider number of entrepreneurs whom for several reasons still do not have access to the information.

Typical courses on TS include topics like, basic concepts of TS, phases of the TS Cycle, TS Cycle related to business, TS for decision making, TS and Competitive Intelligence (CI), essential tools for TS and TS models for Startups.

Improvement Opportunities: Spreading Technological Surveillance Across The community

The following patterns emerge regarding **the uses, needs and availability of scientific knowledge:**

- All science-based startups assessed in the sample were created by scientists (see Table 2) who have access to scientific knowledge.
- There are many startups and pymes[5] (which are not strictly science-based) that require some kind of technology. The access to it could be improved with the knowledge developed by the scientific environment.
- Big companies perform technological surveillance to be updated, because they have the economic resources to do it.

There was also a pattern in that almost all of the science-based startup founders had at least an undergraduate degree in science relevant to the areas of knowledge (scientific and business oriented) required to set up the company.

All entrepreneurs trained in basic science are well prepared to perform research. This trait helps them to be updated but their undergraduate education does not include business skills.

Most entrepreneurs with an engineering degree are used to perform research, which helps them to be updated and, in addition, their undergraduate education includes training in business skills.

Most entrepreneurs without basic science degree or engineering degree are not used to perform research in order to be updated and may or may not have been trained in business skills.

Here there is a huge opportunity to scale the exploitation of the science-based knowledge created by the scientific community in Argentina and across the world, by teaching the different actors in the innovation community what each one needs in terms of technological surveillance.

Final Thoughts

It seems that a proper diffusion of this practice – technological surveillance – and its inclusion in the courses curricula might add value and improve entrepreneurs' competences to capture technological inputs as well as market inputs, that might lead to innovation-driven growth in Argentina, and why not to the rest of the world.

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[5] Pyme: small and medium size companies in Spanish.

Potential Areas for Further Consideration

Additionally, a research on the degree of inclusion of business and management subjects in hard sciences curricula along with activities pointing to develop an interdisciplinary approach among different disciplines could be explored.

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Companies, Recovered from://www.accel.com
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