

Chapter 11

University–Industry Linkage Through Business Incubation: A Case Study of the IPN Incubator in Portugal

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ABSTRACT

This chapter focuses on the role played by business incubators in developing and facilitating knowledge transfer, networks, and business support to tenant firms through a sustainable ecosystem. The authors conduct an in-depth qualitative case-study of one tech-based business incubator in Portugal—IPN, created in 1991 by the University of Coimbra—to provide insight on how the incubator’s direction/management board and a group of incubatees perceive incubation and its impact. Primary data was collected via participant observation/focus group involving the incubators’ CEO and six team members. Semi-structured interviews were carried out among the CEOs and top managers from 11 companies supported by IPN whether as (1) incubates, (2) under acceleration, and (3) graduates. Results show a positive impact of incubation on internationalization and growth for incubatees and companies under acceleration. However, there is a need for new post-incubation follow-up mechanisms and a normative context promoting richer interactions with graduates.

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University-Industry Linkage Through Business Incubation

INTRODUCTION

Business incubators (BIs) became a popular tool to promote entrepreneurship through the creation of new technology-intensive companies (Lewis, 2001). Usually, they offer a set of resources and capabilities to support and accelerate the tenants' development and success (Bruneel, Ratinho, Clarysse, & Groen, 2012; Peña, 2004). BIs have been identified as a new organizational model for the creation of innovative companies (Hannon, 2003), with a critical role in the technology development and innovations (Phan, Siegel, & Wright, 2005; Tsai, Hsieh, Fang, & Lin, 2009), jobs creation (Aernoudt, 2004; Aerts, Matthyssens, & Vandenbempt, 2007) and to prevent the higher risk of failure among new and small companies, characterized by liability of newness (Stinchcombe, 1965) and liability of smallness (Freeman, Carroll, & Hannan, 1983). Typically, the mortality rate of new ventures is higher than among established companies (Aernoudt, 2004).

According to Aerts et al. (2007), BIs guide new companies during their growth process and constitute a strong tool to promote innovation and entrepreneurship. The initial incubator concept was based on business support reduced to the provision of office space (Adkins, 2002), providing low cost facilities (Barrow, 2001). More recently, incubators have increased the offer of business support, namely consultancy, networking and access to venture capital (European Commission, 2002). Nowadays, BIs are aimed at promoting the development of innovative technology-based firms (TBFs) through strategies to develop appropriate mechanisms to help promote their main objectives (Mian, 2014).

In general, BIs support companies on the expectation that they will later be self-sustaining, viable and independent. The combination of services and networking offered by incubators favours survival, contributing positively to reducing the risk of mortality of companies during the start-up period, when they are more vulnerable (Aernoudt, 2004). Nowadays is consensual that BIs "promote and accelerate the development of affiliated companies, helping their survival and growth" (Storopoli, Binder, & Mac-cari, 2013: 42).

We focus on one Portuguese business incubator – Instituto Pedro Nunes (IPN) – created in 1991 by the University of Coimbra (UC), to specifically analyse knowledge transfer, networking business support activities provided by the incubator, according with the tenants (within IPN) and graduates (outside IPN after physical incubation) perspective. Given IPN reputation and resources and organizational capabilities, this incubator has the means to play a critical role in creating a sustainable business ecosystem, with the potential to foster industrial and regional development.

This study aims to understand the business incubator (in this case IPN) as a mechanism or interface for University-Industry interaction, which promotes innovation and technology transfer between academia and companies. To illustrate the case, we look at several companies supported by IPN that are currently in different stages of incubation.

While this study brings academic contribution on the understanding of university-industry linkage through business incubation, it also brings practical contributions for companies, namely: (1) insight into the actual knowledge transfer, networking activities and business support taking place among companies within IPN through favourable ecosystem; (2) insight into the perceived value of these knowledge transfer, networking activities and business support in stimulating the development of the firm and their business growth.

We focus on the organizational level (Aernoudt, 2004; Hackett & Dilts, 2004; Grimaldi & Grandi, 2005), analysing adjustment between services offered by the IPN Incubator through the development of their resources and capabilities (Mian, 1997) and the demand of entrepreneurs and new ventures. In

University-Industry Linkage Through Business Incubation

this context, this study shows: (i) which interactions between IPN and several well succeeded companies facilitate knowledge transfer, networking and business growth, and (ii) how IPN promotes an entrepreneurial ecosystem which favourable to company development.

The paper proceeds as follows. The next section reviews the literature, presenting the main definitions, typologies and general characteristics of BIs and discussing the processes of knowledge transfer, networking developing and business growth. Section 3 describes the methodology used in the study. IPN Incubator is introduced in Section 4, and the results are presented and discussed in Section 5. Finally, Section 6 concludes the Chapter with the conclusions and future research directions.

BACKGROUND

Defining a Business Incubator

A rather large number of definitions of BIs have been suggested in the literature (Hackett & Dilts, 2004; European Commission, 2002). There is no single definition of incubator that is consensual in the literature, but several definitions evolved in the last decades. Thus, there are definitions of business incubation proposed by a broad set of researchers between 1986 and 2000 (Albert & Gaynor, 2001), as a result of extensive literature surveys (Bergek & Norrman, 2008; Hackett & Dilts, 2004), international studies (European Commission, 2002; OECD, 1997), academic papers (Aernoudt, 2004; Sherman & Chappel, 1998) or proposed by associations of incubators (NBIA, 2007; UKBI, 2007). One of the most used definitions is, according with the NBIA (2007), the following: *A business incubator is an economic development tool designed to accelerate the growth and success of entrepreneurial companies through an array of business support resources and services. A business incubator's main goal is to produce successful firms that will leave the program financially viable and freestanding.*

BIs are generally defined as organizations that support new entrepreneurs, aiming at promoting entrepreneurship and innovation (Aerts et al., 2007; Aernoudt, 2004) and can be perceived as a kind of infrastructure geared to support and nurture the establishment and development of new business ventures (Bøllingtoft & Ulhøi, 2005). Although a theoretically meaningful incubator classification is lacking (Hackett & Dilts, 2004), some authors mention that basic key characteristics of BIs can be identified (Hackett & Dilts, 2004; Peters, Rice, & Sundararajan, 2004). According to Hackett and Dilts (2004), these key characteristics are: (i) low price rent, (ii) shared services, (iii) access to network/networking, and (iv) existence of entry/exit policies. Similarly, Peters et al. (2004) mention that the main characteristics are: (i) co-location of the business; (ii) shared services, (iii) management assistance, and (iv) network. Bergek and Norrman (2008) highlight four key dimensions, regarding the business incubation activity, that had received particular attention in previous studies on the topic: (i) shared physical space, which is leased on favourable terms to incubated companies; (ii) a pool of shared support services envisioning cost reduction; (iii) business support or advice (coaching) and (iv) access to internal/external networks (networking).

Hackett and Dilts (2004) identified three main dimensions of incubation: (1) infrastructure; (2) business support services; (3) access to networking. According with the literature, the relative importance of each of these components has varied over time, from initial focus on shared infrastructure (Mian, 1996; Allen & McCluskey, 1990) to a most recent emphasis on the importance of business support services (Peters et al., 2004; Sherman & Chappell, 1998) and access to networking (Hackett & Dilts, 2004; Euro-

University-Industry Linkage Through Business Incubation

pean Commission, 2002). Recently, Baraldi and Havenvid (2016) identifying seven key components of incubation, namely, time, place, sources, resources, control/governance, activities/services and outcomes.

The incubation process has three main phases: (i) pre-incubation aimed at identifying more or less structured business ideas and transforming them into companies; (ii) physical incubation to support the creation of new businesses, providing conditions that contribute to business growth during the incubation period; and (iii) post-incubation outside the business incubator, which translates the graduation of the companies as a successful incubation result (Caetano, 2012). There is little knowledge about business survival and exit dynamics after graduation, and postgraduate research has been largely neglected (Schwartz, 2009). In many cases, there is a lack of information on the location of graduates who left the incubator successfully and there is also lack of data on previously incubated firms in general (Colombo & Delmastro, 2002; Hackett & Dilts, 2004; Schwartz, 2009).

Most empirical research on business incubation focuses on the level of the incubator or incubated enterprises and there are several qualitative studies that highlight the impact of interactions between BIs and entrepreneurs toward successful incubation processes. Some examples are the case studies about Barcelona Activa, a successful BI in Catalonia, Spain (Perdomo, Alvarez, & Urbano, 2014) and two bottom-up BIs located in Denmark (Bøllingtoft, 2012). Nonetheless, post-incubation monitoring of companies by incubators is not very robust (Caetano, 2012). There is a shortage of a consistent set of previous research and discussion of good practices on this particular phenomenon - companies that benefit from incubation programs with success and can provide testimony to other new companies.

Role of Incubators in Developing Knowledge Transfer, Networking, and Business Growth

Knowledge Transfer

BIs – initially conceived to promote firm creation and to bring greater economic diversification at the regional level – have been significantly evolving into a mechanism for increasing regional competitiveness in specialized industries, through the creation of technology-intensive companies. These kinds of incubators are exclusively focused on new technology-based companies (Aerts et al., 2007; Phillips, 2002) and endowed with infrastructure and services suited to the start-up and growth of companies developing emerging technologies (von Zedtwitz, 2003; Hansen, Chesbrough, Nohria, & Sull, 2000). Technology incubators are usually associated with universities (Mian, 1996) and provide specific infrastructures and services, such as access to laboratories, advanced technology, equipment, technical and scientific support including academic faculty, students and specialized libraries (Phillips, 2002). Moreover, linkages with universities and research institutions facilitates technology transfer and commercialization (Phillips, 2002). The last BIs generation concentrates mainly on promising start-ups in the ICT and high-tech sector (European Commission, 2002; Hackett & Dilts, 2004).

The existence of incubator-university links brings added-value to incubatees and graduated companies (Phillips, 2002) and technology BIs play an important role in stimulating innovation and networking in a systemic way: among technology-intensive companies, universities, industry and government representatives (Hansen et al., 2000; Phillimore, 1999). One of the main tools for knowledge transfer is the creation of spin-offs with the support of BIs and a favourable entrepreneurial ecosystem. These incubators are interface institutions that promote innovation and technology transfer between academia and industry. The creation of spin-offs is one of several technology transfer mechanisms created in an

University-Industry Linkage Through Business Incubation

academic environment for the business world (Bercovitz & Feldmann, 2006). For this, the support of the incubators translates into the provision of incubation spaces, infrastructures and shared basic services, specialized equipment and services and networking. These supports may be very relevant to the technology maturity and survival of companies, especially since corporate mortality is highest in the first three years of life (Aernoudt, 2004).

According to Smilor, Gibson, and Dietrich (1990), academic spin-offs take place when a faculty, employee or student, who left university to start the company or while still connected to the university founds a company; and/or when a company is created based on a technological idea developed within the university.

Networking

Previous studies on incubation practices in countries such as the United States and the United Kingdom show that the development of networks and promotion of social capital are the most important support of incubators (Collinson & Gregson, 2003).

Current incubators are mainly focused on new technology-based companies (Aerts et al., 2007) based on clusters and networks, seeking access to external resources, knowledge and legitimacy (Bruneel et al., 2012). According to Chandra, Chao, and Ryans, Jr. (2011), the modern BIs are searching for appropriate affiliations to help promote growth of TBFs through access to networks with different types of external entities. The network exploitation by the BIs provides tenants with preferential access to potential customers, suppliers, technology partners and investors (Hansen et al., 2000). Partnering with other organizations offers opportunity access to resources and acquisition of knowledge (Grant, 1996), acquire new knowledge (Yli-Renko, Autio, & Sapienza, 2001) and develop new capabilities (Lane & Lubatkin, 1998). Consequently, access to networks is the most important factor for successful incubation programs (Hansen et al., 2000), allowing access to networking activities for value creation among incubated enterprises (Hughes, Ireland, & Morgan, 2007).

Having an organized network is emphasised as one of the key factors influencing the emergence and successful development of a new venture (Bøllingtoft, 2012). Networks are seen as critical for the survival and growth of a small firm because they can provide access to advice, information, and influence as well as resources held by others (Birley, 2000; Johannisson, 2000). These networks can include universities, R&D centres (Mian, 1996), other ventures (Bakouros, Mardas, & Varsakelis, 2002), industry players (Hansen et al., 2000), government agencies (Phillimore, 1999) and other organizations and individuals.

According to Rothschild and Darr (2005), both formal and informal networks are crucial in entrepreneurial environment. In fact, apart from offering infrastructure and business services, the opportunity for networking among the tenants is arguably one of the most important services offered by an incubator (Hansen et al., 2000; Lyons, 2000). Furthermore, Sherman and Chappell (1998) suggest that incubator facilitate relationships between tenants. Lyons (2000) suggests that internal and external networks are equally important for the entrepreneur within business incubator. Carayannis and von Zedtwitz (2005) argue that access to networks is one of five types of services that must exist in an incubator. By providing access to networks, incubators facilitate the acquisition of resources and expertise, provide learning opportunities and enable new firms to obtain legitimacy more quickly (Bruneel et al., 2012). The value of networks as part of the explanation for the entrepreneurial success is widely acknowledged (Birley, 2000; Johannisson, 2000; Rothschild & Darr, 2005).

University-Industry Linkage Through Business Incubation

The literature indicates that technological incubators with links to universities and R & D centres can facilitate the access of companies to networks, providing gains in knowledge and technological skills, including protection of intellectual property, scientific and technological knowledge complex, design and production skills that enable the development and commercialization of products and services by companies (Deeds, DeCarolis, & Coombs, 1999).

Business Growth

Performance, development and survival of companies are at the heart of entrepreneurship research (Shane & Venkataraman, 2000) and constitute a major concern for incubator management teams. While accurate measurements of company performance are critical to business research, researchers face a number of difficulties in properly assessing the success and failure of new firms (Chakravarthy, 1986). In fact, reliable data are often more difficult to obtain than with respect to mature firms, and the issue of comparability is an ever-present problem (Kunkel & Hofer, 1991). Business performance has been much studied in order to find out why some companies perform better than others (e.g., Chandler & Hanks, 1993; Lumpkin & Dess, 1996; Peña, 2004). According to Aldrich and Martinez (2001: 41), “*understanding how and why some entrepreneurs succeed remains a major challenge for the entrepreneurship research community*”.

Successful BIs promote business growth through their infrastructures, services and networks and seek to help incubatees become self-sustaining, viable and independent in the future, after leaving the incubator. In terms of business growth, indicators such as turnover growth, employment (Mian, 1997; Peña, 2004), exports and internationalisation of markets (Keeble, Lawson, Smith, Moore, & Wilkinson, 1998), profits (Peña, 2004) or evolution of the number of workers in the last years (Westhead, Wright, & Ucbasaran, 2001) are often considered. All these indicators can be considered to analyse the evolution of companies in different phases of the incubation process.

METHODOLOGY

In this exploratory research, an integrated case study strategy was adopted (Yin, 2003), based on data collected from a relevant case study – IPN Incubator. The data collection process was developed over a period of approximately six months (since September 2015 to March 2016).

The IPN case was selected according to the following criteria: (1) incubator with international recognition; (2) with a technological base and university connection; (3) good integration into the surrounding entrepreneur ecosystem; (4) support for high-tech companies; (5) bet on the growth and internationalization of companies; and (6) self-sustaining and economically viable incubator. IPN has international prestige as evidenced by the “Best Science Based Incubator” award that won in 2010. On one hand, given that the existence of incubator-university links brings added value to companies (Phillips, 2002), IPN is focused on promoting the transfer of technology between academia and business mainly through academic spin-offs. On the other hand, IPN, like other incubators, is also focused on promising developments in the ICT and high technology sector (European Commission, 2002, Hackett & Dilts, 2004). The entrepreneurial ecosystem that surrounds IPN has a strong potential for innovation and entrepreneurship and IPN strives to facilitate businesses growth and enables access to worldwide markets (IPN, 2014).

To collect data on IPN and the companies selected for this study, a combination of documentary analysis, participant observation (Spradley, 1980) and semi-structured interviews was used. The documentary

University-Industry Linkage Through Business Incubation

analysis was based on the access to sources of information with internal data from IPN and the eleven companies chosen, namely information available on the official websites, documents that were made available by interviewees and sampled companies, reports, brochures, databases of financial nature (Dun & Bradstreet) and other archival documents. The participant observation was recorded through the field work, consisting of 10 visits to IPN, with an average duration of two days each, and personal interaction with actors of the IPN community (four leaders and six team members IPN, 30 entrepreneurs, founders of companies supported by IPN, out of which 10 were responsible for the companies in the sample). To support the initial observations and preliminary conversations with actors involved in the IPN environment, a focus group interview was conducted with five participants (a current leader and four members of the IPN management team), with the duration of four hours. Complementarily, ten interviews with companies' founders were developed.

The script of the interview conducted in the focus group with IPN staff consisted of four topics of analysis which are aligned with literature: (1) importance of participating in an entrepreneurship ecosystem around local conditions (Isenberg, 2010); (2) technology transfer process (Hayter & Rooksby, 2016; Kalar & Antoncic, 2015); (3) supply of resources and services associated with incubation processes (Abduh, D'Souza, Quazi, & Burley, 2007; Bergek & Norrman, 2008; Bøllingtoft & Ulhøi, 2005; Mian, 1996); (4) success stories ("visible successes, wealth generation for founders, international reputation", Isenberg, 2011: 7). The information collected in the focus group was relevant in that it allowed to: (i) identify the IPN positioning within the entrepreneurial ecosystem; (ii) understand the current business support practices and value proposition for companies; and, (iii) select the companies referred to as success stories within the IPN community. More specifically, successful business cases with the support of IPN were analysed at different stages of development. In order not to condition the participants, no concept of success was defined at the outset. The construction of the sample with selected cases was done according to the principle of intentional sampling considering the exploratory nature of the study (Coyne, 1997).

In order to operationalize our case study, we use five selective criteria across the eleven companies that benefited from IPN support: technology transfer, networking, internationalization, growth and stage of development regarding the incubation process within IPN. The companies studied were divided into three groups regarding the stage of development in the incubation process: (i) four graduates installed outside the IPN after the incubation period; (ii) three companies participated in the process of acceleration TecBIS, after finishing the physical incubation in 2014; and (iii) four companies are currently undergoing physical incubation.

Table 1 presents a brief description of the eleven companies studied, in terms of physical incubation period, activity sector and position of interviewed. The average incubation period is about five years, ranging from a minimum of three years to a maximum of seven years of incubation. This period of permanence is higher than the international average (three years) and can be justified by the fact the majority of analysed companies are spin-offs with initial difficulties in the transfer and commercialization of the technology. In terms industrial sector, companies operate in seven different areas (as shown in the Table 1), out of which ICT/software represents 45% of the companies studied. From the eleven individual interviews initially envisaged, were obtained ten valid semi-structured interviews with founders of companies for analysis purposes (it was not possible to interview the founder of WIT Software).

University-Industry Linkage Through Business Incubation*Table 1. Characterization of case study companies*

Company	Incubation period	Sector	Position of the interviewed
Active Space Technologies	2006-2011	Electronics and Instrumentation	Chief Executive Officer
Crioestaminal	2003-2007	Biotechnology	Chief Executive Officer
Critical Software	1998-2003	ICT/software	Chief Financial Officer
WIT Software	2001-2006	ICT/software	-
Feedzai	2009-2014	ICT/software	Chief Financial Officer
MedicineOne	2007-2014	ICT/software	Chief Executive Officer
Take the Wind	2008-2014	ICT/software	Chief Executive Officer
Active Aerogels	Until 2013	Materials	Chief Executive Officer
Friday	Until 2014	Maritime Engineering	Chief Executive Officer
iClio	Until 2010	Digital Media	Chief Technology Officer
LaserLeap	Until 2013	Health	Chief Operations Officer

Source: Own elaboration

THE IPN INCUBATOR

In 1991, UC creates IPN - a private non-profit institution that promotes innovation and technology transfer between academia and business. Currently, IPN has an integrated model of action in three main areas, which interact and complement each other: (i) research and technological development (RTD), consultancy and specialized services; (ii) business/ideas incubation and company acceleration; (iii) highly specialized training and promotion of science and technology.

IPN holds its own technological infrastructures composed by six RTD Laboratories in diverse areas, with both national and international links established at various levels with higher education institutions, R&D organizations and companies. This place the incubator in a privileged position to promote innovative activities based on knowledge and to stimulate technology-based entrepreneurship.

Among IPN objectives and activities, business incubation and acceleration are considered crucial to promote entrepreneurship and technology transfer. IPN Incubator hosted the first company in 1995 and was one of the first Portuguese technology-based incubators with capacity for 18 companies. After testing its incubation model oriented toward the on support of university (particularly UC) start-ups and spin-offs, in 2007 IPN and the UC proceeded to the expansion of the Incubator, establishing its capacity in 50 companies. Currently, IPN Incubator provides resources and services in three areas of intervention: (1) infrastructures and basic services; (2) specialized services; and (3) networking. Infrastructures included office space for business installation, meeting rooms, reception services, laboratories, auditorium and bar. The main specialized services offered by IPN are: assistance to the legal constitution of companies in Portugal; with business plan development, accounting services, advice on human resources recruitment and personnel management, marketing plans and advice, intellectual property support, technology transfer support, support services in applications for national and EU grants, coaching, mentoring, training to develop business skills, internationalization support and virtual incubation.

A large range of networks and networking activities are offered by IPN to promote access to potential clients, suppliers, distributors, technology partners, public agencies, venture capital, etc and

University-Industry Linkage Through Business Incubation

stimulate interactions between tenants. IPN provides access to national R&D centres and other sources of knowledge, such as universities. Internal networking activities also are important in IPN's environment through networking events and formal and informal contacts between tenants. IPN also provides access to international networks to facilitate companies' internationalization process. In twenty years of incubation of technology-based companies (1996 - 2015), IPN Incubator presents the following results: (i) incubation applications received per year: over 50; (ii) companies supported: 220; (iii) survival rate: 75% for supported companies; (iv) export rate: 40%; (v) annual business turnover in 2014: € 80 million and, (vi) direct employment: around 2,000 highly qualified jobs created.

In 2014, IPN opened the first business accelerator in Portugal called TecBIS – Technology Business. Innovation. Sustainable Growth. The business accelerator is an “entrepreneurial support infrastructure that follows companies after the incubation stage. It aims to cover the specific needs of enterprises at more advanced stages that are already established in the market and are striving for faster growth and internationalisation” (IPN, 2014: 17). TecBIS promotes the connection to the UC and other entities of the National Scientific System, favouring the entrepreneurial ecosystem in which it participates. The main services provided by TecBIS to the companies in the growth phase are: infrastructures, specialized services and networking such as IPN Incubator but focused on the companies' growing and internationalization. In terms of international networks of accelerators, IPN integrates several networks to enable access to worldwide markets and contacts.

The case of the IPN Incubator shows its efficacy in transferring knowledge and technology between academia and business and in creating networking activities with organizations. IPN Incubator is an example of a modern incubator based on innovation, which is particularly important for new businesses and spin-offs operating in more innovative sectors (e.g., ICT, digital media, biotechnology, materials, health, and other services). IPN added value relies on its effective interface between new ventures and sources of scientific and technological knowledge (Perdomo et al., 2014). The basic key characteristics of incubators identified by Hackett and Dilts (2004) and Peters et al. (2004), such as physical infrastructure, shared business-support services and network/networking can also be identified in the IPN Incubator.

RESULTS AND DISCUSSION

The perceived value of resources and services offered by IPN was directly observable in interviews with entrepreneurs. In general terms, all the interviewees positively valued the resources and services received from IPN. There are three main reasons, according with the firm founders interviewed, for choosing the IPN Incubator. First, the opportunity to access flexible and modern incubation space and a set of shared support services that reduce initial costs. The perceived value of these services is in line with previous results (e.g., Abduh et al., 2007). Second, the company settling in an environment with other peers, conducive to social and professional interactions, international networking and business growth, benefiting from the support of the management team of the incubator. Third, the proximity to the university environment and the participation in the entrepreneurial ecosystem surrounding IPN, to which companies adhere due to the existence of opportunities.

The entrepreneurs interviewed mentioned that IPN is quite well consolidated, promotes technology transfer, stimulates networking activities and looks for acceleration of new businesses through highly specialized support services.

University-Industry Linkage Through Business Incubation

Knowledge Transfer

BIs are often developed to serve technology-based firms (European Commission, 2002). This is also the case in the IPN Incubator, which transfers knowledge from the university to the business environment as one of its main objectives. As one professor and tenant entrepreneur mentioned: *Modern universities seek to influence society, to transfer knowledge and to benefit from this transfer, not only in economic terms but above all in the field of knowledge. The transfer of knowledge is not only from universities to companies, but also from companies to universities and incubators are the proof of this. In this case, the IPN is a fundamental institution for this strategy of university-industry articulation, which allows a strong link between the clusters of the UC and the business fabric with companies.*

In this context, the University-Industry linkage is crucial. The companies within the IPN Incubator emphasized that the incubator was perceived as particularly valuable to the knowledge transfer. As stated by one entrepreneur: *The installation at IPN allows us privileged access to the know-how and areas of research and innovation developed at the UC.*

The technological development is of particular importance in this type of technology-based companies and propensity for innovation.

The case of the IPN Incubator shows their efficacy in transferring knowledge and in creating successful spin-offs, mainly of an academic type. Of the eleven companies analysed only one is not spin-off. These business spin-offs have developed faster than academic spin-offs for a variety of reasons. The results indicate that non-academic spin-offs tend to exploit innovations associated with market opportunities, while academic spin-offs initially focus on the innovative idea. For these companies the support of IPN Incubator is crucial for knowledge transfer.

The market approach strategy varies according with the technological problems to be solved and the sector of activity. One of the barriers identified in the knowledge transfer process lies in the technology maturity of product-based companies. Companies outside ICT have more barriers to entry. As mentioned by entrepreneurs: *We are developing a physical product for health. The maturation time is over, we had to learn step by step. This is a physical process that took two years to improve and we had to do the patenting. This issue does not arise in software development companies that do not need a patent; As long as they have a good idea they can develop it from anywhere.*

In terms of intellectual property, one of the main outputs of business innovation is the number of patents registered (Barbero, Casillas, Ramos & Guitar, 2012). The need for protection of intellectual property varies according to the industry of the company and the markets in which it operates. Most companies rely on IPN's technical support for the protection of intellectual property, especially when it comes to trademark procedures. Another of the barriers identified in knowledge transfer lies in the process of writing patents. In this context, it is common for incubated companies to turn to IPN for support in the process of patenting and licensing the technology, but often also subcontracting other specialized companies. Incubatees often use the simultaneous support of two entities, the IPN itself and an external consulting company. One of the entrepreneurs expressed this in the following way: *In the protection of intellectual property, we have the support of IPN for the registered trademark of one of our products. For the patenting of an innovative product that we intend to commercialize in 2016, we have simultaneously applied to IPN and an outside company specializing in intellectual property and we benefitted from this joint work.*

Graduate companies outside IPN are directly involved in the patenting process; they hire outside companies for this purpose and assume the costs of patenting the technology.

University-Industry Linkage Through Business Incubation

Networking

The analysis of the data collected from company's interviews revealed two major categories of networking: (i) internal networking within IPN community and (ii) external networking with others organizations. The importance of networking is evidenced by the majority of respondents as one of the best supports of IPN. As one entrepreneur said: *IPN's most important support is networking. The network is expensive and hard to get when we do not have the right contacts. When a good incubator like IPN provides us with a lot of networking it makes life easier because it allows us to establish business or institutional relationships easier, which saves us time and money. That was the main benefit we got from the relationship with the IPN.*

Although the interviewees mentioned the existence of informal and formal relationships between companies within the IPN community, this study only obtained major evidence of the main formal links between companies through participation in common projects (e.g., consortium, co-promotion, partnerships) or commercial transactions (customers and suppliers).

In terms of networking activities, the owners of the companies all have different experiences. The very different and varied range of contacts and relationships within the incubator environment played an important role for companies supported by IPN. In terms of formal linkages between companies through participation in common projects (partnerships), seven companies participated as co-promoters in technological development projects involving other companies supported by IPN or in consortium projects. The companies in the process of acceleration are the most involved in these projects, since all participated in these types of partnerships. In contrast, only half of graduated and incubated companies participated in joint projects.

Because of sharing experiences and mutual support, there are companies within the incubator that prefer to have business relationships with other incubated companies, even under less advantageous conditions. As one of the tenants said: *We have several suppliers within companies incubated at IPN. Although the price of services is more expensive, we prefer to hire these companies. It's a way to support them.*

The physical closeness and knowledge of the companies that coexist in a common environment help to establish these relationships. One of the entrepreneurs expressed this in the following way: *Companies feel supported, they share an environment where they are not unique, they often help each other, since some are customers of other companies, and they look for those skills that they lack.*

The links of companies to R&D centres and universities facilitate the development phases of technology and are critical success factors in the maturity of technology companies. In the interviews carried out, we confirmed that all the companies studied had such connections in 2015, and a total of 39 connections with 27 different universities and R&D centres were identified.

The four incubated companies have a strong connection to the UC, linkages to accredited laboratories of the National Scientific and Technological System and connection to IPN's own laboratories. As one of the tenants said: *One of the main functions of IPN is the transfer of knowledge to companies through its laboratories. We have collaborated with LAS on the development of our product. Many of the companies incubated at the IPN resort to their laboratories.*

Obtaining capital is a top priority for new ventures. A good network of contacts with investors facilitates the raising of capital and favours business. In terms of access to risk capital, in the period from 2013 to 2015, five companies benefited from this type of financing, three of them in early-stage incubation and two in acceleration. From this analysis we conclude that only academic spin-offs used venture capital. On the one hand, these companies need higher investments to adapt the innovative idea to the market

University-Industry Linkage Through Business Incubation

and the consumer (Roininen & Ylinenpää, 2009). On the other hand, not all business spin-offs had to resort to this source of funding to expand its business. However, access to international investors needs to be improved, as one entrepreneur said: *IPN has to go further in attracting international investment. It is not enough to bring only national investors to IPN. It is necessary to bring us foreign investors, especially those who bet on technological products.*

IPN supports companies in the early stage of development to elaborate applications in several areas. This is one of IPN's main support services to companies during the first years of its existence. Between 2013 and 2015 all companies had approved projects in several areas of competitiveness, with co-financing of EU funds. The entrepreneurs emphasized that IPN was perceived particularly valuable to the company through the contacts network and supporting in applications for national and EU grants, more crucial than others support services. As one entrepreneur said: *The best IPN has is the networking and its Project Office that supports the companies to make applications to national and community programs and this the IPN does very well. They know in depth the programs that exist to support companies, and we entrepreneurs do not have to waste time looking for this information or studying the regulations that are sometimes complex and focus on the core business of the company; they help all incubated companies and they do a good job.*

Business Growth

In this context, the analysis of the data collected from interviews revealed that IPN has two main aims related to business support: (i) to promote access to international markets (new businesses and start-ups which are usually characterized by high entry barriers) and (ii) to increase business growth in terms of exports, employment and turnover.

The entrepreneurs emphasized that IPN Incubator was perceived as particularly valuable to the tenants in facilitating access to international markets during the first years of company existence. This internationalisation support is offered by IPN through soft-landing networks, enabling access to worldwide markets and contacts, partnerships in projects involving an international component for their companies. Additionally, IPN and external mentors are closely connected to other Portuguese speaking countries. As one entrepreneur said: *IPN was instrumental in consolidating our business model. The support given to the strategy of internationalization of the company, from a wide network of contacts, allowed to expand the activity for Spain and Italy.*

In terms of geographic markets of goods or services sold, nine of the companies studied are present in international markets. Two incubated companies have already started their internationalization process, have potential markets in which they prepare the entrance with their products as soon as the technology is established, through partners and representations, but by the end of 2015 they had not yet done so the first international sale.

One of the barriers identified in the internationalization process is in the process of recruiting partners and professionals in foreign markets. At the level of exports, it is crucial to know the right people to enter the markets. As one entrepreneur from one of the companies undergoing the acceleration program said: *The main obstacle that we have felt in exports is getting to the right people quickly, especially when we do not have a local network. Here the support of IPN has been important. We have already participated in IPN's corporate missions to Germany, Brazil and USA.*

University-Industry Linkage Through Business Incubation

IPN Incubator also impacts on companies' growth. As one of the entrepreneurs explains: *Incubation at IPN, the resulting networking and participation in business acceleration programs have proven to be essential for achieving sustainable organic growth (by 2014 our company grew 85 percent).*

IPN's support for corporate performance is highlighted by the majority of respondents, especially those of companies currently based at the BI. As one entrepreneur stated: *The IPN has a culture of its own that entails understanding the entrepreneur, knowing how to think like the entrepreneur, see what difficulties he has and help, focusing on results. I find this in IPN's culture, a strong focus on business and results. IPN creates value and helps companies creating value.*

Role of IPN Incubator in Developing and Facilitating Knowledge Transfer, Networking, and Business Growth Through a Sustainable Ecosystem

One of the main reasons pointed out by the founders of companies to choose the IPN Incubator is the importance of affiliation in an entrepreneurial ecosystem attractive. As referred by the founders, this ecosystem that surrounds IPN has a strong potential for innovation and entrepreneurship, to which companies adhere driven by the growth opportunities. Participation in this ecosystem is highly valued by companies. As one entrepreneur said: *The very entrepreneurial ecosystem that IPN creates with the companies and entities involved is the greatest benefit we have had, the most valuable support for the growth of our company.*

The coexistence of companies with several characteristics that have the possibility to participate in a same ecosystem and to exchange experiences is also mentioned. One of the entrepreneurs said: *IPN has created a very favourable ecosystem for the growth of companies creating conditions that are very interesting for any company.*

The economies of agglomeration and economic specialization that characterize certain regions are at the basis of entrepreneurial ecosystems (Mason & Brown, 2014). According to Cohen (2006), an entrepreneurial ecosystem is seen as a set of interacting, connected actors committed to sustainable development in supporting the creation and development of new businesses, contributing to the growth and progress of their community. Its performance has to be measured in the long run, since its results do not arise from one day to the next (Isenberg, 2011).

In knowledge-based economies, innovation is a critical factor and strongly depends on the Triple Helix of university-industry-government interactions (Etzkowitz, 2002). The IPN Incubator is one of the privileged actors in these processes and provides the entrepreneurs with technological infrastructure, specialized services and access to networks that facilitate the creation and development of companies. The importance of incubators for the dissemination of innovative activities in the productive sector is underlined by several studies (Lundvall, Johnson, Andersen, & Dalum, 2002; Vedovello & Godinho, 2003). Innovation is seen as an interactive learning process and technological innovation as an endogenous factor of development (Lundvall, 1992). To promote the interaction of companies with the entrepreneurial ecosystem, the relevant role of the incubator is to involve and motivate new companies to participate in this business environment. Therefore, to enable a business Incubator to embed its companies and entrepreneurs in an entrepreneurial ecosystem, it is proposed that:

Proposition 1: The venture tenants seek BIs not only for resources and capabilities, but also for their entrepreneurial ecosystem.

University-Industry Linkage Through Business Incubation

According to the resource-based view of the firm, resources and capabilities of BIs promote quickly the creation of new ventures and business growth (Perdomo et al., 2014). BIs provide a variety of resources and capabilities to adjust supply and demand for products and services between incubator and entrepreneurs, which facilitates networking and business growth. In assessing the impact of incubators in general, there is a need to obtain feedback directly from the entrepreneurs and greater priority should be given to this than previously has been the case (European Commission, 2002). In this context, there is a need to obtain feedback directly from the entrepreneurs to enhancing services offered by business incubator.

Furthermore, the entrepreneurs need to share immediate feedback with incubator management in which questions and responses are adapted on a daily basis, as the incubation process progresses. In other hand, the physical proximity facilitates ongoing interactions between BIs and entrepreneurs and appears to promote the use of networking activities and increase business growth opportunities. Thus, we put forward the following proposed:

Proposition 2: Business incubators develop their capabilities from the relationship between their offered services and the demand of entrepreneurs, which facilitate networking and business growth.

Previous studies have found that the role played by BIs has evolved from the mere facility and service provider into consultancy organizations focused on knowledge, resources, and policy coordination for both enterprises and national innovation systems (Scillitoe & Chakrabarti, 2010), with the systematic construction of networking and supporting companies towards business growth. BIs develop their capabilities through validation of models and methodologies for technical assistance and financial support, networking, business, and technology, among other capabilities that are installed to improve enterprise creation and business growth (Bøllingtoft & Ulhøi, 2005; Tötterman & Sten, 2005; Scillitoe & Chakrabarti, 2010).

These findings expand previous knowledge on BIs by pointing at the fact that incubators that wish to facilitate and stimulate networking and cooperation activities between the incubator, its tenants and external environment, must ensure that incubatees also have opportunities for sharing knowledge, transferring technology and internationalize and help building a sustainable business ecosystem around the incubator.

CONCLUSION

In this study, we analysed eleven companies and entrepreneurs' perceptions on knowledge transfer, networking and business growth; we also sought to identify how companies perceive IPN contributions to these dimensions of analysis.

The influence of the entrepreneurial ecosystem designed around IPN in the creation of spin-offs and in business development is shown in the results of this study. The first objective was to contribute with insight into the knowledge transfer, networking and business growth taking place among companies supported by IPN. Entrepreneurs realize that they are part of an ecosystem that allow leveraging the business and also emphasize the crucial role IPN play in reinforcing this ecosystem. More than the resources and capabilities it offers, IPN Incubator is seen as an organization that mobilizes the actors of the system through a strong network of contacts, relationships with external partners and exchange of experiences

University-Industry Linkage Through Business Incubation

that bring added value to entrepreneurs. This has been contributing for creating a sustainable ecosystem around IPN which facilitates entrepreneurial success.

The second objective was to contribute with insight into the perceived value of these knowledge transfer, networking and business growth to stimulate the business development. From a company's perspective, the analysis has illustrated that IPN supports all companies, regardless of their stage of development, but is more robust and close to incubated and accelerating companies.

One of the main processes of knowledge transfer through IPN is the creation of spinoffs, especially from academia. In terms of business development, the impact of IPN support varies according to the sector of activity. For the IPN Incubator it is easier to support ICT/software spinoffs than spinoffs based on other types of technological products, particular the ones that take longer to reach technological maturity. This issue raises a case-by-case approach to the type of business under analysis that cannot be neglected. In the field of industrial property (IP), the needs of companies and the experience of IPN were examined. In terms of IP protection, most incubators find it difficult to meet business requirements. IPN support is adequate for supporting the protection of IP. However, such support is easier when it comes to establishing registered trademarks or copyright for companies in ICT/software areas than to develop patents for other technological products. In the process of patenting, it is common for companies to use specialized consulting firms to support patent search, writing and application.

Among the network activities developed by the companies, we verify that IPN facilitates networking and promotes access to other external organizations. In this context, companies can easily relate to universities and R&D centres and venture capitalists. On one hand, it is easier for IPN to establish formal rather than informal networks and support early-stage companies to access such contacts. The IPN team is very competent in obtaining funding through EU grants. On the other hand, it is more difficult for IPN to support graduated companies, which are already independent, and to attract to the IPN itself foreign investors interested in technological products companies.

Within the scope of business growth, we observe that IPN facilitates the internationalization process, especially of incubated and accelerated companies. While on the one hand it is easier for IPN to support early stage companies to access foreign markets. On the other hand, it is more difficult for IPN to support the recruitment of partners and professionals abroad who are one of the biggest difficulties for companies. This is an area of low impact, which can be improved by strengthening international networks and increasing the internationalization skills of the IPN team.

Regarding the business growth, a longitudinal analysis was considered with exports, employment and annual turnover between 2013 and 2015. The results seem to show that IPN's support is more important for growth of incubated companies that are more vulnerable at the initial stages, which is in agreement with the literature (Aernoudt, 2004). There is no evidence that IPN support favours the growth of graduated companies abroad. These companies have been continuously showing less connections with IPN and their growth is achieved by their own means.

In summary, access to the incubation and acceleration processes mainly benefit companies at their initial stages of activity. The importance of IPN support diminishes as graduated firms become viable and independent, with an autonomous market approach. In addition to the selection/entry criteria, incubators must also establish criteria for the exit of companies (Hackett & Dilts, 2004). On one hand, the fact that IPN does not have strict criteria for companies leaving the incubator (e.g., maximum period of three years), having flexibility in the incubation period can allow for the construction of a strong connection to the incubated companies, which gives them security, originating a better reputation and a more sustained growth, especially when it comes to spin-offs. On the other hand, this situation can

University-Industry Linkage Through Business Incubation

sometimes contribute to delays in the development of the company, dependence on the incubator or accommodation. In the case of the IPN Incubator there is flexibility in these criteria but its management team must pay renewed attention to the exit policies.

The empirical evidence does not show a direct relationship between graduates' performance and IPN support, but for the incubated and accelerated companies this support is very important. These companies are more embedded in the IPN ecosystem and need more support because of their vulnerabilities at early stages of activity. In contrast, graduates are more independent and have in-house competencies that do not require the various types of support available in the incubator. However, IPN Incubator should reinforce post-incubation follow-up mechanisms. Moreover, some measures can be devised to increase the interaction between graduates and incubatees. For example, encouraging graduates to participate in projects in partnership with incubated companies or creating a network of companies with the "IPN brand".

This study has limitations that need to be acknowledged and addressed. The first limitation concerns the fact that, although we focus on representative incubator in Portugal, the analysis is specific to a sample of several Portuguese companies. Although the Portuguese case may resemble the incubation dynamics among other Southern European countries, our results should not be generalized or extrapolated to other geographical contexts, which calls for other country-level analyses and international comparisons on the topic. On the other hand, this study is also limited in scope, because does not consider a wide range of networking activities among entrepreneurs within technology BIs. Thus, the present analysis strictly observes the relationships between studied companies and others actors through formal linkages within incubator (e.g., project partners, customers, suppliers) and outside of incubator with R&D centres and universities. Notwithstanding, incubators can gain from other actors such as government agencies, business consultants, entrepreneurial associations and other organizations (Perdomo et al., 2014).

This research lacks analysis on the early-stage business failures within incubator or failure in the post-incubation stage. Firms' needs (demand) and business support (supply) characteristics may vary according different life-cycle stages, thus dynamic analyses would offer additional interesting insights at this respect.

Further qualitative and/or quantitative research (under the format of case studies, for example) could be used to develop research comparing how specific international incubators and incubated companies perform, as compared with similar companies (size, industry, age) installed outside the incubators.

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University-Industry Linkage Through Business Incubation

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KEY TERMS AND DEFINITIONS

Business Incubator: A tool for economic development designed to accelerate the growth and success of businesses through a broad set of resources and services to support new firms (infrastructure, specialized services, access to networks), most vulnerable in the early stages.

Business Growth: Refers to the growth of companies through the expansion of their business in regional, national or international markets, resulting from the combination of resources and capacities used in the production of marketable goods or services that increase business performance over a period of time compared to previous periods (e.g., sales turnover, market share, job creation, internationalization).

Entrepreneurial Ecosystem: A set of entrepreneurial actors (both potential and existing) interacting in shared context, which formally and informally come together to connect, mediate and govern performance within the local entrepreneurial environment, namely, entrepreneurial organizations (e.g., firms, venture capitalists, business angels), institutions (universities, public sector agencies, R&D agencies), and entrepreneurial processes (e.g., the entrepreneurial activity rate, numbers of high growth firms).

Knowledge Transfer: Refers to the process of transferring knowledge produced in technological-based entities and scientific research to other organizations, especially companies, associated with innovation. Knowledge transfer has a very broad context, but in this case, it is understood as the mechanism that allows the new knowledge produced by public research to be transferable to companies, namely through technology commercialization, intellectual/industrial property licensing, creation of spinoffs, to obtain technological maturity and business survival in early-stage phases.

Networking: Interaction activities among network actors (individual and collective actors such as, companies, organizations) based on a set of inter-organizational relationships built and developed through relationships, ties and links between actors who formally and informally cooperate with each other, in order to acquire and share information, knowledge, resources, learning opportunities and value creation at a personal and entrepreneurial level.