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Innovation practices in small technology-based companies during incubation and post-incubation periods

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Abstract

Purpose – Innovation is a constant attribute in the management processes of technology-based companies (TBCs), mostly small and young, and plays a relevant role in their competitiveness and survival. However, the authors assumed that the characteristics of innovation practices differ between incubated and post-incubated companies, in such aspects as formality, type, posture and strategy. The purpose of this paper is to report the innovation practices identified in small TBCs in the incubation and post-incubation periods (graduate companies).

Design/methodology/approach – To achieve the purpose, the authors carried out a multiple case study with four TBCs, two incubated and two post-incubated (graduate); the study was qualitative and exploratory, and the authors collected data with their managers.

Findings – The results show that these companies have high levels of innovation, which is a determinant factor for their presence in the business market; they create technological innovations in products and services, mostly incremental, such as improvements in existing products or reduction of internal costs of manufacturing. In addition, the results also show important features of the innovations, such as the interaction with other incubated companies and with universities and research centers.

Originality/value – The authors conclude that there were changes in innovation practices, in the transition from incubated to graduate companies, such as the formalization of processes, a shift in focus toward the customer and an increase in resources and in projects' relevance.

Keywords Innovation, Incubation, Small firm, Technology-based company, Post-incubation

Paper type Research paper

1. Introduction

Small companies are relevant for the economy and the society due to the large number of ventures, the movement of financial resources, job generation (Berends *et al.*, 2014, Halme and Korpela, 2014; Portal Brasil, 2015) and for developing technology and innovations that

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serve specific niches and contribute to market dispersion (Klewitz and Hansen, 2014). Small firms have greater flexibility and agility in decision-making as compared to large corporations, but their resources and skills are more limited, and they lack the organizational and marketing capacities of large companies. These features create challenges for innovation efforts (Berends *et al.*, 2014).

Innovation prevails in technology-based companies (TBCs), since they are organizations that apply scientific and technical knowledge for the creation of innovative products. They are described as small, young (less than 10 years old), make significant technological efforts and develop new ideas for products, processes and services; consequently, they generate and depend on innovation (Oliva *et al.*, 2005; Pinho *et al.*, 2005; Sanches and Machado, 2013; Zarzewska-Bielawska, 2012). Small TBCs stand out in innovation because of the synergy with other companies and their simple organizational structure (Baraldi and Havenvid, 2016, Colombo *et al.*, 2014). Thereby, they achieve growth and survival in the market (Jong and Marsili, 2006).

Many small-scale TBCs start their activities in business incubators, as they provide support and infrastructure for the development of innovative ideas. Companies' graduation takes place after a defined period, according to the incubator's policies and rules (Baraldi and Havenvid, 2016). The result of incubation for graduate firms (post-incubated) is the value created by the incubator's internal environment, which increases their market occupation rate, capitalization, patent generation and higher profits.

Therefore, the study of innovation in small TBCs is relevant due to their economic and social character, and because it is the foundation for their growth, development and survival. Innovation provides a competitive advantage and a higher profitability for small firms, since it is carried out more quickly (Bhaskaran, 2006; Damanpour, 1996).

Despite the researchers' interest in these organizations (Mian *et al.*, 2016; De Paula *et al.*, 2015; Pinho *et al.*, 2005), the literature on innovation does not address properly the small business segment (Berends *et al.*, 2014), as well as the attributes that distinguish it from large firms (Moultrie *et al.*, 2007). There is little knowledge about their features, especially the management of TBCs and their innovation practices, whether incubated or post-incubated (De Paula *et al.*, 2015). In addition, there are some gaps in the literature, mainly regarding the period of incubation and post-incubation and innovation activities in graduate companies (Albort-Morant and Ribeiro-Soriano, 2016; Mian *et al.*, 2016).

When these firms change from incubated to graduate, they no longer enjoy the benefits of the incubation environment. Therefore, the characteristics of their innovation practices differ in formality, type, attitude and strategy. However, innovativeness (the need for continuous generation of innovations) is still important for post-incubation ventures (Aragão, 2005; De Paula *et al.*, 2015; Tumelero, 2012).

In view of the above context, the objective of this article was to identify the innovation practices of small TBCs during their periods of incubation and post-incubation (graduate companies).

The paper contributes to advance knowledge on the innovation processes during incubation and post-incubation periods. Through the identification, analysis and systematization of the relevant variables of this process, we intend to collaborate for a better understanding of innovation in incubated and graduate small companies, taking into account the complex and dynamic environment in which they operate.

The article has five sections including this introduction, which shows TBCs' attributes regarding innovation and the need to understand the innovative process in incubated and post-incubated companies. Section 2 presents the main theoretical approaches underlying the studies on the subject; Section 3 describes the methodological procedures and the

characterization of the investigated companies. Section 4 presents the results, where we find the innovation practices identified in incubated and graduate companies. Finally, Section 5 presents the conclusions, with some observations and considerations on the research.

2. Literature review

2.1 Innovation

To innovate implies developing activities in a different way from that used in an organization and to take initiatives to improve products, processes or procedures, increasing their value and performance (Damanpour, 1996). Innovation can be defined in four areas: product, process, marketing and organization (Mortensen *et al.*, 2005). Another possible classification regards the environment in which innovation takes place, which can be commercial, organizational and institutional. Innovations take place through three types of contributions (Bhaskaran, 2006; Lipparini and Sobrero, 1994): radical innovation, which is the development of a radically new product; architectural innovation, which consists of a significant improvement of a product and involves major changes in its composition and subsystems; and incremental innovation, which regards improvements in a product and/or reduction of internal costs for its manufacturing. Innovation means the introduction of improvements and changes, incremental or radical, conditioned by the company's ability to innovate in search of competitive advantage (Mortensen *et al.*, 2005; Sanches and Machado, 2013).

A frequent term for small TBCs and very close to innovation is invention, which refers to an expressive value added to the state of science, attributes of novelty, creativity and industrial application. It can be entitled industrial patent or utility model and receive the benefits established by law (Alário and Oliveira, 2000). But inventions only become meaningful when they turn into a practical application (Schumpeter, 1982).

A company is considered to be innovative when it conducts at least one successful innovation; when it is in the process of developing a product or service not yet finalized (in progress); or when its innovations have not been used before being implemented (Mortensen *et al.*, 2005). However, the measurement of innovation in TBCs is still incipient, and both types of firms – incubated and graduate – need a direction, based on the problems they deal with, sectors of activity and level of development. Innovation indicators for small TBCs are divided into the following categories: market alignment; management and planning; potential for company development; product and technology; team; social and environmental impact; financial; and commercial (De Paula *et al.*, 2015).

When it comes to innovation in small-scale TBCs, they can be classified according to some factors: the type of strategic attitudes, the manager's decision-making and an aggressive or conservative posture in the market (Santos *et al.*, 2007); the technological strategic planning, through an innovative, imitative or follower position (Zawislak *et al.*, 1998); the degree of technology and the market, whether low, intermediate or advanced; and the formality of innovation practices, whether formal or informal (Fonseca and Kruglianskas, 2002). Hence, given the variety of propositions, this is a multidisciplinary field. A deeper analysis is needed to understand innovation in incubated and post-incubated companies (Mian *et al.*, 2016), which is the proposition of this article.

2.2 Innovation in small TBCs

Small TBCs seek competitiveness in the economic setting through innovation, to have a distinguished product or service in the market, to achieve success and higher chances of survival (Ferrari *et al.*, 2002; Jong and Marsili, 2006).

These firms have room for the development of innovation because they enter the market with new ideas for products and processes, by means of partnerships and cooperation with companies, acquired through their network of contacts; through the mechanisms and the organizational structure they use, with strong internal control, an attitude towards the innovation chain and internalization of the operations; and through the nonstop search of innovation, given the context of resource restriction (Baraldi and Havenvid, 2016, Colombo *et al.*, 2014).

There are few studies on innovation in small TBCs (Inácio, 2008; De Paula *et al.*, 2015). The importance of studying innovation in these companies is due to their new ideas for products and services, to keep the company in the market (Jong and Marsili, 2006) and for the economic development (Baraldi and Havenvid, 2016).

In addition, small TBCs require more specialized activities such as interaction and synergy with companies, universities and public institutions for research and development (R&D), benchmarking (knowledge exchange) and for products' marketing and trade (Mortensen *et al.*, 2005). Innovation activities for small- and medium-sized enterprises (SMEs) are divided in four types: formal internal (R&D); formal external (trade relations and technology transfer); informal internal (invention and accumulated knowledge) and informal external (imitation or copy, external contacts) (Fonseca and Kruglianskas, 2002). Unlike SMEs that lack resources for innovation, small TBCs have a revenue model based on profit, both through the logic of venture capital and financial investment (Baraldi and Havenvid, 2016).

Small TBCs are important for the innovation process because they share several innovations with the market, to get greater profits and higher participation and key contributions, that is, outstanding technological innovations for the market (Lipparini and Sobrero, 1994). The relevance of incubators for the creation and development of innovation in small TBCs should be highlighted (Mian *et al.*, 2016).

The important features of small TBCs for the innovation process are the competitive advantages derived from their external links with collaborative suppliers, universities, research centers, public sector, associations and incubators (Lipparini and Sobrero, 1994). These links include researchers, scientists and technical professionals that keep formal and informal ties with universities, thus obtaining easy access and technical knowledge (Fonseca and Kruglianskas, 2002). In addition, small TBCs in incubators gain access to the network of contacts and receive managerial support, strengthening both the exploitation of their strategy as well as growth and market positioning (Soetanto and Jack, 2016).

2.3 Incubation and post-incubation

The incubator is a process of training the entrepreneurial organizations for their proper functioning. It turns theoretical knowledge into practices of these companies. The incubator movement in Brazil represented a new direction for science, technology and industry policies for Latin America. It led to a low-cost development, with benefits coming from universities, industry and government resources (Etzkowitz *et al.*, 2005).

Incubators are important for business innovation. We can examine an incubator through the *triple helix*[1] approach, its infrastructure, its network of contacts and its services to companies. They provide the infrastructure for the establishment of offices, meeting rooms, spaces for interaction and laboratories; business services such as seminars and training on finance, marketing, intellectual property, that is, managerial and technical services, with training and information on accounting and legal services; and access to a network of contacts with other companies (synergy) and to financing (Carvalho and Galina, 2015).

There are several types of incubators in Brazil such as technology-based incubators, traditional incubators, incubators for cooperatives and private incubators. The technology-based incubator, object of this article, presents as attributes the need of smaller resources for its establishment, the relevant role of universities for its development, as well as partnerships with the government and the industrial sector for technology financing and development (Almeida, 2005). In addition, the technology-based incubator houses companies that present a high innovation potential (De Paula *et al.*, 2015).

Studies that address incubators and incubated companies in Brazil are based on services and management of personnel and information. There are still many areas to be explored, such as internal features, relations between incubators and the three aspects that define the incubator (triple helix) (Carvalho and Galina, 2015; Tietz *et al.*, 2015). We highlight the gap regarding research with post-incubated companies as the object of study. Two Brazilian authors investigated the form of survival of these firms, mentioning the entrepreneurial actions and the establishment of business condominiums as a response to the problem (Aragão, 2005; Tumelero, 2012). However, there is still an absence of studies related to the internal characteristics of both incubated and graduate companies, such as the strategic process and innovation practices.

We notice that the gap regarding investigation of the internal attributes of the incubated and, mainly, of the post-incubated companies does not happen only in Brazil. International studies of incubators focus on the most diverse aspects, such as: the feminist perspective of TBCs entrepreneurs (Marlow and McAdam, 2015); the state-of-the-art knowledge of technology-based incubators (Mian *et al.*, 2016); and the international bibliometric analysis of business incubators (Albort-Morant and Ribeiro-Soriano, 2016). An exception is the paper by Baraldi and Havenvid (2016), in which they examine the new dimensions of incubators. However, the analysis of these internal features occurs only in incubators and incubated companies, excluding graduate companies. Therefore, there is an important reason to study the internal attributes of innovation in incubated and post-incubated companies.

3. Methodology

To answer the research question, we carried out an exploratory, qualitative and applied research (Cooper and Schindler, 2016). The technical procedure is a multiple case study with four TBCs located in São Carlos, SP, two in the process of incubation and two that have graduate. We collected information on their innovation practices but did not compare the cases to find common features (Yin, 2015).

The state of São Paulo has 13 technology poles. São Carlos Technology Park (ParqTec) was established in 1985, and it is considered as the first Brazilian technology park. The city of São Carlos, together with Campinas and São José dos Campos, is recognized as one of the main technology centers of the state and shelters around 180 TBCs [Parque Tecnológico de São Carlos (ParqTec), 2017; Secretaria de Desenvolvimento Econômico, Ciência, Tecnologia e Inovação do Estado de São Paulo (SDECTI), 2017].

To identify the companies, we initially used a list with the small and medium firms of the city, created from information provided by ParqTec and CIESP (Center of Industries of the State of São Paulo). To update this reference list and find other companies, we made contacts with the Secretariat of Sustainable Development, Science and Technology of the Municipality of São Carlos/SP and with the Development Center of Nascent Industries (CEDIN), at the Incubator of Tourism Companies.

After the identification of incubated and graduated companies, we conducted an interview with the incubator manager. After this stage, we selected the two companies in the process of incubation and the two graduate companies, both from the same incubator. The

cases were chosen based on the survey of small TBCs, considering the following criteria: sector (industrial technology-based companies), situated or having passed through incubators (incubated and graduate companies), small size (number of employees) and geographical location (São Carlos). Among the identified companies, the criterion adopted for selection was access to entrepreneurs, that is, convenience. It is worth noting that many companies (incubated and graduate) did not answer the e-mails and initial phone calls. After the interviews with the incubator manager and with incubated Company 1, it became easier to schedule interviews, due to the contact and synergy between incubated and graduate companies.

Data collection was done through interviews, based on a structured script, with those responsible for the companies' management and, consequently, for the innovation practices. Results of the interviews were compared with the literature review (data analysis technique), by relating small business management concepts to the innovation practices of each company.

3.1 Innovation practices of technology-based companies

Table I summarizes the attributes of incubated Companies (1 and 2) and graduate Companies (3 and 4), followed by the sections that describe the context of the companies' start-up, types of synergy and innovation practices and attitudes.

3.1.1 Incubated Company 1. The creation of the company resulted from a business opportunity. The firm operated as a *spin-off[2]* for another company in developing a machine project. On doing this, they identified an opportunity to open a formal company to provide this type of service. Thus, we consider that the objective and motivation for creating the venture was a market opportunity. The initial financial resources came from a contract established with the client company, for a one-year period, to render the service.

The type of dominant synergy used for innovation practices was the business synergy between the incubated companies. The firm made contacts with universities and research centers, such as the Mechatronics Laboratory and the Integrated Nucleus of the Hydrographic Basin, both of the São Carlos School of Engineering, Institute of Technological Research, Institute of Energy and Nuclear Research and Information Technology Center. It also made benchmarking with other companies and suppliers, considered as innovation sources.

Attributes	Incubated Company 1	Incubated Company 2	Graduate Company 3	Graduate Company 4
Foundation	2007	2011	2010	2003
Incubation	2009	2011	2011	2006
Graduation	X	X	2013	2009
Sector	Precision mechanics/ Automation	Biotechnology	Medical/Dental	Precision mechanics/ Automation
Employees (number)	02	05	08	04
Partners (number)	02	04	03	02
Reason for creation	Market opportunity	Market opportunity and possibility to continue developing applied research	Market opportunity	Market opportunity

Table I. Attributes of the investigated companies

The leader considered the company innovative, either through the sale of a product of its own or a technology consulting service. He also considered innovation important, because without it there would be no business. Innovations in services and processes stand out. The company carried out technological innovations on sources of renewable resources (energy and hydric) and in the development of technology. The most common type of innovation was incremental, and his business was based on this type of innovation, but he considered that radical innovation would be the goal.

The company adopted an aggressive posture, but with respect to innovation, it is a follower. It developed inventions and got patents, one of them an equipment for reutilization of rainwater. The company has an advanced degree of technology and market. The ideas or opportunities for innovation emerge from customers' demands (external market demand), which were previously developed by the owners.

Regarding the formality of innovation practices, the leader considered that it was informal (he chose 2 on a scale of 1 to 5, informal and formal). The difference in innovation practices from its foundation until now is that, in the beginning, innovation focused on owners' actions and presently it comes from customers' requests and market demands.

3.1.2 Incubated Company 2. The company was founded with resources from the PIPE/FAPESP program (Innovative Research in Small Companies, of the State of São Paulo Foundation for Research Support), to trade products developed by the BIOMICS group of the São Carlos Institute of Chemistry. They decided to undertake as a market opportunity and to extend the applied research.

The types of synergy for innovation practices were operational and technological. For this, they established contacts and partnerships with universities and research centers, such as the University of São Paulo (USP), the Brazilian Company of Agricultural Research (EMBRAPA), the Federal University of São Carlos and the Paraná Agronomic Institute. Such contacts are considered a source of innovation, since they drive product development. The company also makes benchmarking with other firms, as an innovation practice. The exchange of information with EMBRAPA and USP was a source of innovation that generated knowledge and was later applied to products.

The company is considered innovative because it develops products of high impact and high technology according to market needs (customers). To the leader, innovation was extremely important, because it resulted in the development of products, without which the company would not exist. The outstanding innovation was product innovation, as in the case of the development and production of kits for fast diagnosis. The most common type of innovation is incremental, where an imported product is modified, resulting in a similar product for the domestic market.

The company adopted a conservative attitude. However, before the product was launched in the market, there was an identification with the innovative posture, since the company acted in a reactive way. They have not carried out an invention yet, but when the products are finished, they will apply for patents. The degree of technology and market was considered advanced, but there was no large-scale production. Ideas or opportunities for innovation arise from customers' needs, R&D, trade fairs and competitors.

Regarding formality, the company was undergoing a structuring process with a tendency to formalize its activities and processes – it started as informal but with the execution of projects and product development it was becoming more formal each day.

3.1.3 Graduate Company 3. The beginning of the company resulted from two Master and PhD projects. The objective was to develop products in the dentistry area, and they saw a business opportunity. The initial resources came from their own savings and the remainder from development agencies.

The synergy used for innovation practices was of the business type. The leader contacted university researchers, because they are his customers and a source of innovation, due to the constant flow of interaction and information. They made benchmarking with other companies and suppliers, but they did not consider this activity as a source of innovation, because they needed to add other features to become an effective innovation.

The head of the company considered it innovative because he always looked for other ways to develop and differentiate his products and reduce costs. Innovation was important, since it distinguished the company from the others – they adopted the product differentiation strategy (exclusive product), in which product innovation stands out. They made technological innovations by creating products that did not exist, with the idea coming from the customers. The most common types of innovation were incremental and architectural (the radical occurs a few times). By having a superior equipment, the company does not compete on prices. The attitude regarding innovation is aggressive.

The firm has already made several inventions and was granted two patents (one product is on the market and another is under development). The degree of technology and market depends on the product developed. Ideas and opportunities for innovation arise from customers' demand, from the discussion originating from R&D and from initial ideas that need to be developed. With respect to formality of innovation practices, we identified a transition from informal to formal. To the leader, there was a difference in the innovation practices from the creation of the company up to the present, because before it was "detached from the market" (innovation just for the sake of it) and today innovation is market oriented.

3.1.4 Graduate Company 4. The company started with a PhD project developed at USP and relied on the knowledge of partners such as Foundation for Research Increase and Industrial Improvement and the development of some projects. The goal was to serve some companies, and they decided to undertake as a market opportunity. They used their own financial resources to open the company (they started activities in the house of one of the partners).

Innovation practices used business and technology synergies. They established contacts with universities and research centers, such as USP and UNICAMP (State University of Campinas), considered as sources of innovation, as they provided the development of new ideas. They made benchmarking with other companies and suppliers, also considered a source of innovation and a follow-up on "how other companies are doing".

To the leader, the company was innovative because the products were unique and considered as a scientific project for industry. Thus, innovation was important for the firm, which was born out of innovation and looks for it continuously. Innovation is considered essential for the company's survival.

Product and service innovations stand out. They made technological innovations by using state-of-the-art innovative technologies and innovative products. The types of innovation most common in the company were incremental and architectural. The type of posture regarding innovation was conservative, but the intention was to be proactive and more aggressive again.

The company has already invented a product and other innovative products (software) are waiting for release. It applied for a product patent (the same as the invention). Ideas or opportunities emerged in the company from customers, employees, R&D, trade fairs and competitors.

Regarding the formality of innovation practices, the company was at Level 4 on a scale from 1 (informal) to 5 (formal), therefore being formal. At the beginning of activities, innovation practices were more informal, but there were changes up to the present, and

some practices were "lost", by reducing their informal character and becoming formal and explicit.

4. Innovation practices in TBCS: analysis and discussion of results

The most common type of innovation in companies is the commercial product innovation, through the creation of a new product or the improvement of an existing one, as pointed out by Mortensen *et al.* (2005). Innovation is incremental, with the enhancement of an existing product and/or reduction of internal costs for its manufacturing (Bhaskaran, 2006; Lipparini and Sobrero, 1994). Incremental innovation of commercial products is common in the researched companies due to their internal characteristics and highly skilled technical employees, proximity to customers, synergy originating from incubators and business contacts, as mentioned by several authors (Carvalho and Galina, 2015; Jong and Marsili, 2006; Lipparini and Sobrero, 1994). Only graduate companies present architectural innovations, through the change of a product's composition, due to the growth and maturity acquired by the firm.

The field of small incubated and post-incubated TBCs is heterogeneous and diversified. The investigated companies acted in different areas such as sources of renewable resources and technology development (incubated Company 1), process of development and manufacturing of fast diagnosis kits for plants (incubated Company 2), creation of new products by customer demand (graduate Company 3) and innovative technologies and products (graduate Company 4). The similarity between them was the development of technological innovations.

Given the high degree of the companies' technological innovation, patents and inventions stand out. Three companies have already developed inventions and patented products (incubated Company 1, graduate Companies 3 and 4). Incubated Company 2 has never made any invention, but it intends to apply for patents for its products, which are in the development phase. This fact confirms the literature, which mentions that small TBCs make a large number of inventions with practical applications and register patents (Alário and Oliveira, 2000; Schumpeter, 1982).

Once again, this field is highly diversified with innovations in very different areas. The results of implementing projects that were patented or generated new products were considered successful innovation activities – for example, we include the creation of new products, but exclude process innovation activities or those abandoned, according to Mortensen *et al.* (2005). Incubated Company 1 filed a patent, incubated Company 2 intended to patent three products, graduate Company 3 patented two products and graduate Company 4 patented one product. This criterion is important to measure innovation on incubated and post-incubated TBCs, considered as incipient (De Paula *et al.*, 2015).

The companies' innovation practices consisted of specialized activities, such as interaction with incubated companies, contacts with universities and research centers, R&D, benchmarking and financing from development agencies. These actions are in line with innovation practices highlighted by several authors, such as Fonseca and Kruglianskas (2002), Mian *et al.* (2016), Mortensen *et al.*, (2005) and Soetanto and Jack (2016).

For the investigated TBCs, innovation process is relevant, considered as a form of market entry, besides guaranteeing higher profits with the development and subsequent sale of new products and consequently achieving companies' growth. Some authors also mention that innovation is a variable that directly affects the performance of companies, keeping the market and increasing their profits (Zarzewska-Bielawska, 2012).

TBCs carry out a large number of innovations, precisely to continue to develop the company and bring advances to the scientific world, considered as key innovations,

according to some authors (Ferrari *et al.*, 2002; Jong and Marsili, 2006). They are faster in absorbing changes of the external market, and their more informal communication brings agility to the process of innovation. Other aspects that facilitate the innovation process are: external contacts with suppliers and clients, who participate in stages of the innovation process; links with universities and development agencies, to get information and project grants; technical knowledge of the partners and the organizational structure, with strong internal control and informal communication (Baraldi and Havenvid, 2016; Colombo *et al.*, 2014; Lipparini and Sobrero 1994).

All companies consider themselves innovative, for a variety of reasons: they develop and sell a unique product; they offer a technology consulting service; they search for other ways to develop products and differentiation; and they provide scientific projects developed for industry. All companies are concerned with providing differentiated technological products, a premise of innovation. Other features related to the companies' innovation practices are the best application, development and introduction of innovations in the market; agility in the introduction of products in the market; proximity to customers and suppliers; ease of financing; geographical location in technologically advanced sectors; and contacts and other benefits provided by the incubator. These aspects confirm the literature (Baraldi and Havenvid, 2016; Bhaskaran, 2006; Carvalho and Galina, 2015; Damanpour, 1996; Fonseca and Kruglianskas, 2002; Lipparini and Sobrero, 1994; Soetanto and Jack, 2016).

Small-scale TBCs are created by technical professionals, scientists and researchers, who seek to keep close links with research environments and universities, which facilitates the innovation process (Fonseca and Kruglianskas, 2002). With respect to the companies' attitude in the innovation process, two of them have a conservative posture (incubated Company 2 and graduate Company 4) and two are considered aggressive (incubated Company 1 and graduate Company 2) (Santos *et al.*, 2007). The attitude adopted by the company relates to its strategy in the market. One company is a follower (incubated Company 1) and the other three claim to be innovators (Zawislak *et al.*, 1998). Regarding the degree of technology and market used by the company, three companies consider themselves in an advanced stage (incubated Company 1, incubated Company 2 and graduate company 4). Graduate Company 3 considers itself in an intermediate stage, but the leader says that it strongly depends on the developed product (Fonseca and Kruglianskas, 2002). Therefore, possessing advanced technology is also an attribute for the innovation practices of incubated and graduate companies.

The ideas or opportunities for innovation in companies arise from customers, employees, R&D, fairs and competitors (Lipparini and Sobrero, 1994). All leaders answered that, in their companies, they emerge from the market (customers) and highlighted the different external links (Lipparini and Sobrero, 1994) and the synergy with incubated companies (Carvalho and Galina, 2015). The proximity to customers becomes a differential for the innovation practices of these firms.

As mentioned in the literature, incubation is a differential for companies by providing a low-cost guided development of a new venture, networking and business synergy, managerial and administrative infrastructure and business services (Carvalho and Galina, 2015; Etzkowitz *et al.*, 2005). The technology-based incubator, where the investigated companies were established, also provided an internal and external environment favorable for the development of innovation practices (Almeida, 2005; De Paula *et al.*, 2015). Hence, it housed companies with high levels of innovation and provided conditions for graduate firms to keep developing properly.

Regarding the formality of the companies' innovation practices, the results show an informal process with a trend to formalization, and this is the main difference, since their

creation until now. The organizational structure changes from a simple structure with informal communication and lack of hierarchical lines, to a mechanistic structure of bureaucracy, with formalized procedures and incipient hierarchy, which affects the formality of innovation practices. In addition, graduate TBCs still lack mechanisms of grouping that provide synergy for innovation practices, as indicated by Aragão (2005) and Tumelero (2012). Figure 1 shows the relationship between the formality of innovation practices and incubated and graduate companies.

Finally, the main changes in innovation practices from the incubation period to graduation are the change of focus toward the customer and the increase of resources and relevance (volume and capacity) of projects. The change of organizational structure and the decrease of synergy between the companies are also factors that affect innovation practices. This study took a step forward, precisely by considering innovation after the incubation period, which is a research gap in the area. Table II presents a brief analysis of the innovation practices of the investigated companies.

Therefore, innovation practices in small-scale TBCs consist of survival in the business market, action in the most diverse areas of technology, development of inventions and patent applications, as pointed out by Baraldi and Havenvid (2016), Jong and Marsili (2006) and Klewitz and Hansen (2014). In addition, innovation strategy in most cases is follower, technology degree is intermediate or advanced, and as for the level of formality, it is more informal in incubated firms and more formalized in graduate companies, regulated by the company's growth. Once again, we stress the importance of innovation studies of small TBCs in the incubation period and especially in the post-incubation period.

5. Conclusions

This study addressed the innovation practices of small TBCs in the incubation and post-incubation periods. Small-scale TBCs showed a high degree of innovation. Thus, they depend on it, especially on technological innovation, for their growth and success. With more innovations, and consequently, new products, processes or services, they can get better performance, higher profits and competitive advantage. Innovation comes from their technical character, the need to adapt to the market, proximity to customers and suppliers and their simple communication system.

Innovation practices are informal in incubated companies and tend to be more formal and standardized in graduate firms. Another point to highlight is the synergy of the incubation process that influences innovation practices. All companies emphasized that the differential of being incubated is precisely to be in an environment with other firms, which serves as a parameter of development and exchange of information and contacts that undoubtedly foster the development of innovation practices.

The predominant variables in the innovation practices of incubated companies are the synergy between companies in the incubator, a simple organizational structure with informal communication, proximity to customers and suppliers and the benefits offered by

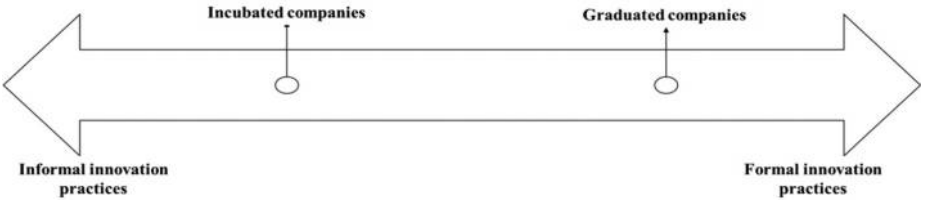

Figure 1.
Relationship between formality in innovation practices and incubated and graduate companies

Table II.
Characteristics of TBCs' innovation process

Innovation process	Incubated Company 1	Incubated Company 2	Graduate Company 3	Graduate Company 4
Type of technological innovations	Sources of renewable resources and technology development	Development and manufacturing process of fast diagnosis kits for plants	Creation of new products from customers' demand	Innovative technologies and products
Patents	Yes	Will apply for	Yes	Yes
Inventions	Yes	No	Yes	Yes
Attitude	Aggressive	Conservative	Aggressive	Conservative
Relationship with innovation (strategy)	Follower	Innovative	Innovative	Innovative
Degree of technology and market	Advanced	Advanced	Intermediary	Advanced
Level of formality of practices	More informal	More informal	More formal	More formal

the incubator. For graduate companies, the predominant variables in innovation practices are the change of focus in the development of new products and services, which were previously proposed by companies' managers and shifted to market demand and requests from specific customers; the structuring of the company, especially the R&D area; hiring of qualified and technical employees; and increase in physical space and available resources, especially subsidies from development agencies.

The research contributes to the literature by examining an internal attribute, the innovation practices, not only in incubated companies but also in post-incubated companies, trying to close a gap in this topic.

Notes

1. This approach assumes the interaction, in a dynamic relational network of agents, of three helices (university – companies – government) that seek the production of knowledge, technological innovation and economic development (Etzkowitz & Leydesdorff, 2000).
2. *Spin offs* are processes and movements of generation of new firms or businesses from established companies, universities and research centers (Filion & Dolabela, 2008).

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