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MODELS OF INNOVATION IN UNIVERSITY-COMPANY INTERACTION: OBSERVATIONS IN INNOVATION AGENCIES AND BUSINESS ORGANIZATIONS

MODELOS DE INOVAÇÃO NA INTERAÇÃO UNIVERSIDADE-EMPRESA: OBSERVAÇÕES EM AGÊNCIAS DE INOVAÇÃO E ORGANIZAÇÕES EMPRESARIAIS

MODELOS DE INNOVACIÓN EN LA INTERACCIÓN UNIVERSIDAD-EMPRESA: OBSERVACIONES EN AGENCIAS DE INNOVACIÓN Y ORGANIZACIONES EMPRESARIALES

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Abstract

Objective of the study: The objective of the research was to identify which types of innovation are most recurrent in Brazilian companies and innovation agencies in interaction and technology transfer actions.

Methodology: The methodological premise was theoretical-empirical and descriptive, with analysis of the data extracted by means of questionnaires and interviews from the sample of innovation agencies affiliated to FORTEC and associated companies at ANPEI and ANPROTEC.

Originality/Relevance: In the literature, no research has been identified highlighting the most recurrent types of innovation in technology transfer processes between Brazilian companies and innovation agencies.

Main results: Incremental innovation was the most recurrent in the interaction processes of companies and innovation agencies, as well as the rates of radical and disruptive innovation obtained a satisfactory average in the interval of the Likert scale.

Theoretical/methodological contributions: This research contributed to the identification of innovation models with greater frequency in the interaction between Brazilian innovation companies and agencies, using the method for future surveys of other interactive forms of the surveyed actors.

Social/management contributions: The results identified in the research can stimulate actions to intensify the interactions and processes of technological transfer between Brazilian companies and innovation agencies.

Keywords: Innovation models. University-company interaction. Technology transfer.

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Resumo

Objetivo do estudo: O objetivo da pesquisa foi identificar quais os tipos de inovação mais recorrentes nas empresas e agências de inovação brasileiras em ações de interação e transferência tecnológica.

Metodologia: A premissa metodológica foi teórica-empírica e descritiva, com análise dos dados extraídos por meio de questionários e entrevistas pela amostra de agências de inovação filiadas ao FORTEC e empresas associadas na ANPEI e ANPROTEC.

Originalidade/Relevância: Não foi identificada na literatura, pesquisa com o recorte dos tipos de inovação mais recorrentes nos processos de transferência tecnológica entre empresas e agências de inovação brasileiras.

Principais resultados: A inovação incremental foi a mais recorrente nos processos de interação das empresas e agências de inovação, como também os índices de inovação radical e disruptiva obtiveram média satisfatória no intervalo da escala Likert.

Contribuições teóricas/metodológicas: A pesquisa contribuiu para a identificação dos modelos de inovação com maior frequência na interação de empresas e agências de inovação brasileiras, com uso do método para futuros levantamentos de outras formas interativas dos atores pesquisados.

Contribuições sociais/para a gestão: Os resultados identificados na pesquisa podem estimular ações para intensificar as interações e processos de transferência tecnológica entre empresas e agências de inovação brasileiras.

Palavras-chave: Modelos de inovação. Interação universidade-empresa. Transferência tecnológica.

Resumen

Objetivo del estudio: El objetivo de la investigación fue identificar qué tipos de innovación son más recurrentes en las empresas y agencias de innovación brasileñas en las acciones de interacción y transferencia de tecnología.

Metodologia: La premisa metodológica fue teórico-empírica y descriptiva, con análisis de los datos extraídos a través de cuestionarios y entrevistas por la muestra de agencias de innovación afiliadas a FORTEC y empresas asociadas a ANPEI y ANPROTEC.

Originalidad/Relevancia: No se han identificado investigaciones en la literatura que destaquen los tipos de innovación más recurrentes en los procesos de transferencia de tecnología entre empresas y las agencias de innovación brasileñas.

Resultados principales: La innovación incremental fue la más recurrente en los procesos de interacción de empresas y agencias de innovación, así como los índices de innovación radical y disruptiva obtuvieron una media satisfactoria en el intervalo de la escala Likert.

Contribuciones teóricas/metodológicas: La investigación contribuyó a la identificación de modelos de innovación con mayor frecuencia en la interacción de empresas y agencias de innovación brasileñas, utilizando el método para futuras encuestas de otras formas interactivas de los actores encuestados.

Contribuciones sociales/de gestión: Los resultados identificados en la investigación pueden estimular acciones para intensificar las interacciones y procesos de transferencia tecnológica entre empresas y las agencias de innovación brasileñas.

Palabras clave: Modelos de innovación. Interacción universidad-empresa. Transferencia tecnológica.

1 Introduction

The innovative process can be presented in various formats in society and in the marketplace. For the Oslo Manual issued by the Organization for Economic Cooperation and Development (OECD, 2005), innovation enables new knowledge to be created and disseminated through the introduction of new products and productive methods of operation. It

is mentioned in the manual that the strategic choice of a particular type of innovation can be the direction of the competitive character in a market.

In the literature on innovation, efforts are observed to determine options for their application in organizational structures (Pavitt, 2006). Tidd and Bessant (2015) note that the act of innovating applies not only to opening new markets, but also to being able to offer new ways to serve existing markets. The authors highlight the need to rethink innovation opportunities and their different formats.

In this context, the identification of types of innovation by business organizations can be strategic for their forays into the market. For example, the Oslo Manual specifies the product and process innovations (OECD, 2005). There are also other ways of presenting the concept of innovation, characterizing it as exploratory, disruptive, radical and incremental (Markides, 2006; OECD, 2005).

The positioning of the types of innovation that universities and research centers adopt for their research can be conflicting with the short-term needs of business organizations, thus preventing a synergy of interaction and greater transfer of knowledge and technology. Identifying each actor's efforts to find the most recurrent type of innovation in their actions can be a way to achieve this synergy.

From a company's perspective, the strategic choice of what type of innovation your R&D area will prioritize can, in many cases, determine your competitive position in the markets. In this context, the research question arises: what types of innovation are more recurrent in processes of interaction and technology transfer carried out by innovation agencies and the companies?

By way of this approach, this research aimed to identify which are the most recurrent types of innovation in Brazilian companies and innovation agencies in actions of interaction and technology transfer. These companies are associated with technology parks and incubators affiliated with the Associação Nacional de Entidades Promotoras de Empreendedorismo Inovador (ANPROTEC) and Associação Nacional de Pesquisa e Desenvolvimento das Empresas Inovadoras (ANPEI) and the innovation agencies registered at the Fórum Nacional de Gestores de Inovação e Transferência de Tecnologia (FORTEC).

At a first moment, questionnaires were applied to companies, obtaining 100 (one hundred) responses and, sequentially, to innovation managers with 59 (fifty-nine) respondents. In sequence, interviews were conducted with seven innovation managers in order to present

their perceptions about the most recurrent types of innovation in university-company interaction.

This research was justified because the aim was to seek, in the Brazilian reality, a tendency of efforts and actions of educational and research institutions and organizational R&D areas in the most recurrent types of innovation. Thus, the scope of this work to approach innovation companies and agencies is justified by the fact that they are proactive in innovative actions in the university-company interaction process.

The decision to focus on FORTEC, ANPROTEC and ANPEI entities was made in that they represent, in Brazil, a significant group of actors linked to innovation. In terms of theoretical contribution, this research has pointed out that incremental innovation is the most recurrent in the Brazilian context, as well as the presentation of categories that demonstrate innovative types in the country. In a practical way, the results contribute to delineate the strategic focus of the institutions within the scope of actions of the innovation process.

As regards research structure, the theoretical concepts of innovation and their formats and open innovation as a strategic option of university-company interaction were approached. Then, the methodological procedures were presented, with subsequent analysis and discussion of the results. Finally, the final considerations and suggestions for future research were obtained.

2 Literature review

2.1 Innovation and its formats

The concept of innovation has diverse clippings in the literature and various forms of action. One of the currents that can be attributed to what Utterback (1971) highlights as a consequence of an invention that hits the market, stems from the exercise of an idea to solve a particular problem to its application with the required returns. This perspective can also be observed in Afuah (1998) when it comes to the knowledge generated to develop a new product or service that consumers want.

On the other hand, Zilber, Lex, Moraes, Perez, Vidal and Corrêa (2008) associate innovation as a creative process, either in the search for different applications for something that already exists, or for the realization of different contexts of knowledge to provide new solutions. Along these lines, innovation should be characterized as a process that brings together political, economic, cultural and technological factors in a society (Dosi, 1982; Powell &

Grodal, 2006; Tang, 1998). It is also presented by Zien and Buckler (1997) that companies can adopt an innovative culture focused on achieving a competitive advantage.

There is also a theoretical current that reports innovation as a process to achieve competitive advantage (Gupta & Trusko, 2014; Ireland & Webb, 2007; Mcgrath, Tsai, Venkataraman & Macmillan, 1996; Mello, Lima, Vilas Boas, Sbragia & Marx, 2008; Porter, 1990) and another that relates innovation as a process for achieving organizational performance (Alegre, Lapiedra, & Chiva, 2006; Brito, Brito, & Morganti, 2009; Camisón & Villar-López, 2010; Hill & Rothaermel, 2003; Klomp & Van Leeuwen, 2001; Lahiri & Narayanan, 2013; Lengnick-Hall, 1992; Tidd & Bessant, 2015).

In the context of forms of innovation, these may vary depending on the research options defined by research institutions and their market applications by companies. The Oslo Manual, produced by the OECD to collect data on technological innovation, is structured on the Schumpterian perspective (Schumpeter, 1982) and highlights that through innovation, new knowledge is created and disseminated, with the expansion of economic potential for the development of new products and productive methods of operation. The OECD explains that the innovative process can be typified in innovations of product, process, marketing and organizational (OECD, 2005, p. 41).

The authors Damanpour, Szabat and Evan (1989) have already classified the innovations in techniques and administrative, with suggestions of the latest innovation being responsible for preparing a favorable environment for the occurrence of the previous one, whose focus is more technological. From the perspective of Tidd and Bessant (2015, p. 27), the concept of innovation can be classified as products (changes in things), processes (changes in forms), positions (changes in context) and paradigms (changes in mental models).

In addition, innovation can be classified as incremental, radical (Henderson & Clark, 1990; OECD, 2005) and disruptive (Bower & Christensen, 1995; Christensen, McDonald, Altman, & Palmer, 2016; Markides, 2006) formats. Incremental innovation focuses on complementing product characteristics that are already established in the market. Radical innovation causes significant changes in products and processes. Jansen, Van den Bosch and Volberda (2006) explain that companies should pay attention to levels of investment in innovation because, in the case of radical innovation, short-term profit margins can be compromised.

In disruptive innovation, the focus is to suggest new concepts that create disruption in established market structures, introducing new technologies and value concepts that impact new

products and services, as well as structural effects on markets and competition. It is pointed out that radical innovations are disruptive, but not always disruptive innovation can be presented as radical, given the purpose if its application and effect (Bower & Christensen, 1995; Christensen, 1997; Markides, 2006).

In the literature (Benner & Tushman, 2003; Jansen, Van Den Bosch, & Volberda, 2006) other definitions of innovation are also identified, such as exploratory ones that are more focused on reflecting long-term radical change and which will significantly change conceptions, products and services on the market (Howells & Tether, 2004).

Drucker (2013) explains social innovation as an option to seek better quality of life for people in the economic sphere, with the involvement of government agencies and the society to meet the required social demands. The author points out that innovative demands, in many cases, emerge from the latent needs of society to address a deficiency that affects their quality of life.

2.2 The open innovation option as a university-industry interaction strategy

Chesbrough's (2003) conceptualization about open innovation as a new perspective for companies to leverage innovative processes as opposed to closed models in their research and development (R&D) areas can be considered a latent approach in the theoretical areas of innovation.

It is observed that increasing competitiveness exposes companies to greater risks in their business. Another aspect involved is the restriction of people involved in the development of innovative projects within business organizations (Chesbrough, 2003).

In the clipping of partnerships, it is pointed out by Christensen (2006) that the concept of open innovation enhances the strategic option of adding value to the business through technology-based projects, especially in markets with intense competitiveness. Another point of the author is the possibility of generating more ideas by the internal teams added to the absorption of research and projects externally by the companies.

In another research by Chesbrough (2007), there is also the option of increasing profitability by companies with the incorporation of the concept of open innovation, either by absorbing technologies in the form of licenses and concessions, or by sharing structures and knowledge with other organizations.

A form of interaction commonly reported in the open innovation literature is the university-enterprise interaction (Plonski, 1999) which, despite differences in scope and

temporalities of universities and research centers and companies on the design of a particular technology (Du, Leten , & Vanhaverbeke, 2014), there may be several points of congruence in this relationship.

Stal, Nohara and Chagas Júnior (2014) highlight that closed innovation can create points of interactions with agents outside the business organization and, in the context of open innovation, there is a more systematic interaction with these actors focusing on obtaining skills and efforts in the generation of innovations, specifically with universities and research centers on embryonic projects.

In another perspective, open innovation can be related to organizational performance actions, leveraging revenues through new product launches, abbreviation of technological solutions, risk reduction and recognition the R&D teams from the viewpoint that the congruence of internal and external resources can intensify innovation projects (Chesbrough, 2003, 2006; West, Salter, Vanhaverbeke, & Chesbrough, 2014).

The research by Greco, Grimaldi and Cricelli (2016) points out that open innovation is related to radically new products that are linked to economic and industrial performance with their application and, therefore, suggest that companies actively collaborate with external organizations to develop and succeed in the market with radical products.

In the context of observing innovative action as a strategy, it is presented by Teece (1986) that technological innovation can add value to existing products and services in companies, as well as contribute to productivity gains. The author also discusses the strategic decisions of business organizations to develop technologies within their limits or absorb them externally.

By the same reasoning, Damampour, Szabat and Evan (1989) report that types of long-term innovation can impact organizational performance, insofar as the processes for adapting changes to the environment are carried out synergistically and aligned with objectives. Porter (1990) also explained that acts of innovation generate business competitive advantage, mainly through the insertion of new technologies and new ways of doing things in the market.

Lengnick-Hall (1992) notes that, if innovation is prospected to complement and enable the distinct competencies of companies, it can lead to a competitive advantage. Rogers (2003), on the other hand, points out that innovation can widen economic inequality in markets, with a tendency to benefit those whith heavy investment in innovative projects.

It is addressed by Gupta and Trusko (2014) that the innovation strategy should be considered as a long-term commitment, taking in consideration the perspective of sustained

growth for the organization as well. The authors add that it should be a means to seize opportunities and achieve success in a given market segment, as well as value the stakeholders involved in the business.

In innovation actions through university-company interaction, Da Silva and Segatto (2017) point out that in order to produce innovation, the university must also be innovative, aiming to restructure internally to acquire innovative capacity.

Thus, the types of innovation are closely dependent on the strategic choice the company will adopt, especially when it relates to the need for short-, medium- and long-term results.

3 Methodology

The research had as methodological premise the theoretical-empirical and descriptive format (Creswell, 2010). At the outset, an analysis of the data extracted from the field applied questionnaires was performed. The research sample was based on innovation agencies affiliated with FORTEC and companies classified as associates, graduates and incubated, which are part of ANPEI and ANPROTEC associations. This choice was justified because they are business organizations involved in innovation projects and direct or indirect interaction with universities and research centers. The questionnaires were created taking into consideration observed control variables related to sector, size, invoicing, time of existence and function performed.

The measurement indicators were extracted based on the literature and anchored in the research objectives. After that, items were measured using the seven-point Likert scale between never occurs and always occurs (Malhotra, 2011). Table 1, below, presents the role played by the indicators and theoretical basis on the construction of the research questionnaire.

Table 1 – Guiding items for questionnaire construction

Dimension	Guiding item	Theoretical basis
INNOVATION	Incremental Innovation - Improving Existing Products and Services	Henderson & Clark (1990); OCDE (2005)
	Radical Innovation - Profound Change in Existing Products and Services	Henderson & Clark (1990); OCDE (2005)
	Disruptive Innovation - Rupture and Replacement of Existing Products and Services	Bower & Christensen (1995); Christensen et al. (2016); Markides (2006)
	Open innovation - absorbing innovation from outside the organization	Chesbrough (2003); Christensen (2006)
	Completely new ways in innovation are perceived as strategic	Teece (1986); Damanpour, Szabat, & Evan (1989); Lengnick-Hall (1992); Rogers (2003); Cantwell (2006); Porter (1990); Gupta & Trusko (2014)

Source: Prepared by the authors.

With the identified scales, a pre-test with seven experienced researchers was conducted to identify possible semantic distortions in the questions, ambiguities and interpretation difficulties by the respondents. Then, the Google Forms platform was used to insert questions and send them to respondents. After applying the research, the data were tabulated and processed in the software SPSS version 20 (Hair, Black, Babin, & Anderson, 2005; Malhotra, 2011).

In summary, the delimitation focused on the responses of the members of the innovation agencies related in FORTEC and the associated companies of ANPROTEC AND ANPEI, for the purpose of comparing the results of each actor before the construct. The approach through faculty and technicians in institutions and research centers, and members of the areas of research and development (R&D) in business structures was the strategy used to collect data in the field to obtain the necessary sample.

With the survey of the companies that are registered in the associations ANPEI and ANPROTEC, emails were sent with the shortcut to the questionnaire created on the Google Forms platform. Altogether, there were eight hundred and sixty-two companies in the collection of the ANPROTEC database and one hundred and fifty-five companies from ANPEI, with a return of one hundred responses by the companies, which represented approximately 10% (ten percent) of return from the total approaches. With the innovation agencies registered with FORTEC, an email was sent to two hundred and five innovation agencies and obtained fifty-nine responses, which represents approximately 29% (twenty-nine percent) of the surveyed agencies.

The interviews with the seven innovation managers took place as it was convenient to the researchers, through an event organized by FORTEC, with subsequent scheduling of the interviewees. To preserve the identity of the interviewees, the following coding was carried out, as shown in Table 2.

Table 2 – Typification and coding of respondents

Interview sequence	Coding	Acting region
Interview 1	E1	Sudeste
Interview 2	E2	Sudeste
Interview 3	E3	Sudeste
Interview 4	E4	Sul
Interview 5	E5	Sul
Interview 6	E6	Sul
Interview 7	E7	Sudeste

Source: Prepared by the authors

Respondents have a management role in the structures of the NITs that operate, commonly in director and middle management positions, according to the definitions of functional structures by each institution.

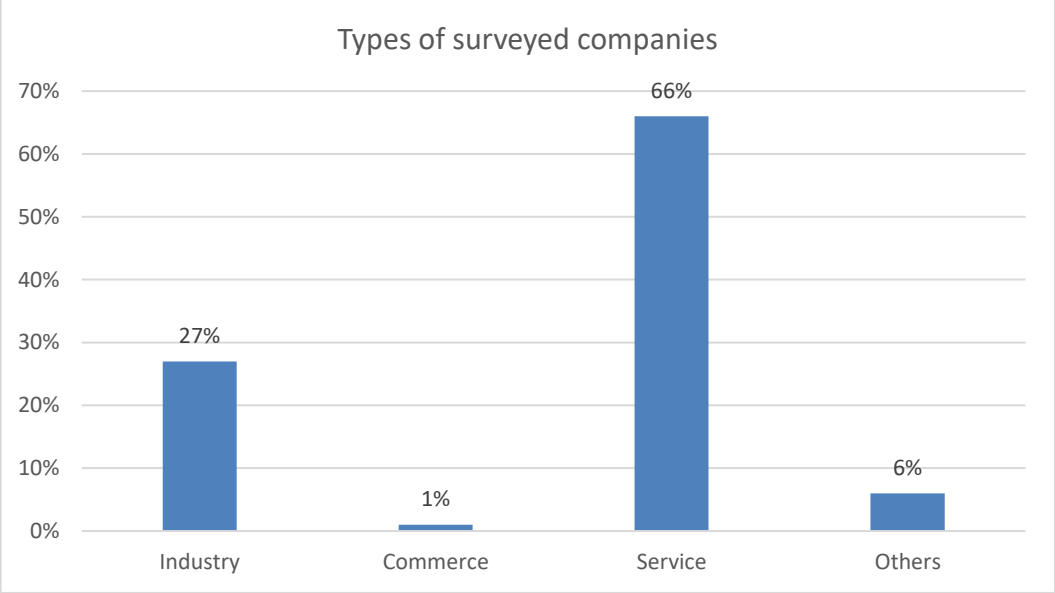
4 Results analysis and discussion

4.1 Survey of types of innovation by companies and innovation agencies

First, descriptive analyses of the samples represented by the companies and innovation agencies was conducted. All in all, 100 returns were obtained from companies registered with ANPROTEC and ANPEI and 59 answers were collected from innovation agencies registered with FORTEC. Both questionnaires were answered through the Google Forms platform.

As regards the samples of the companies, the following profiles were identified, as shown in Figure 1.

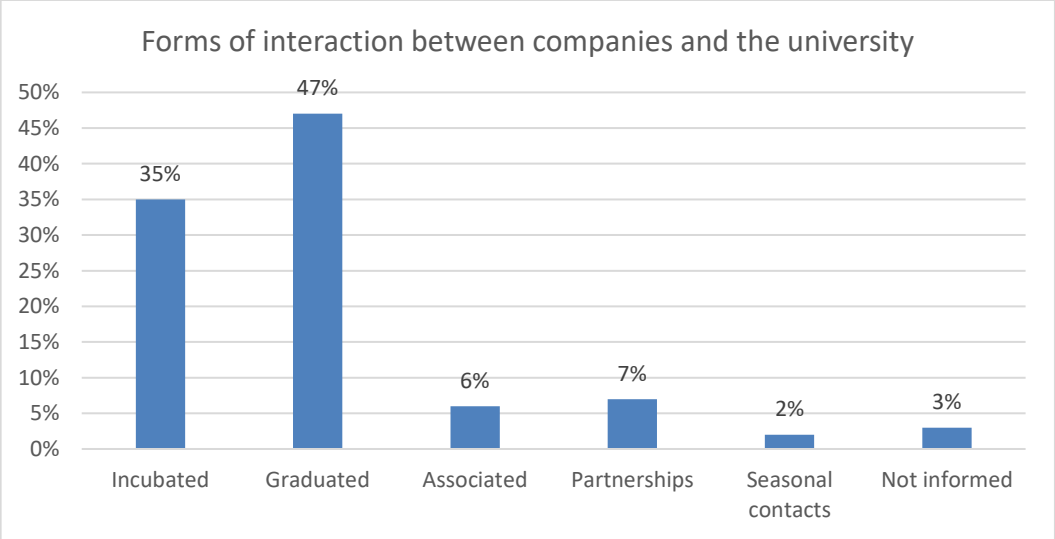
Figure 1 – Types of surveyed companies



Note: The percentages of the business relate to a sample of 100 respondents.
Source: Prepared by the authors from SPSS version 20

Concerning the form of interaction with universities, Figure 2 shows how this relationship is characterized by companies.

Figure 2 – Forms of interaction between companies and the university



Note: The percentages of the business relate to a sample of 100 respondents.
Source: Prepared by the authors from SPSS version 20

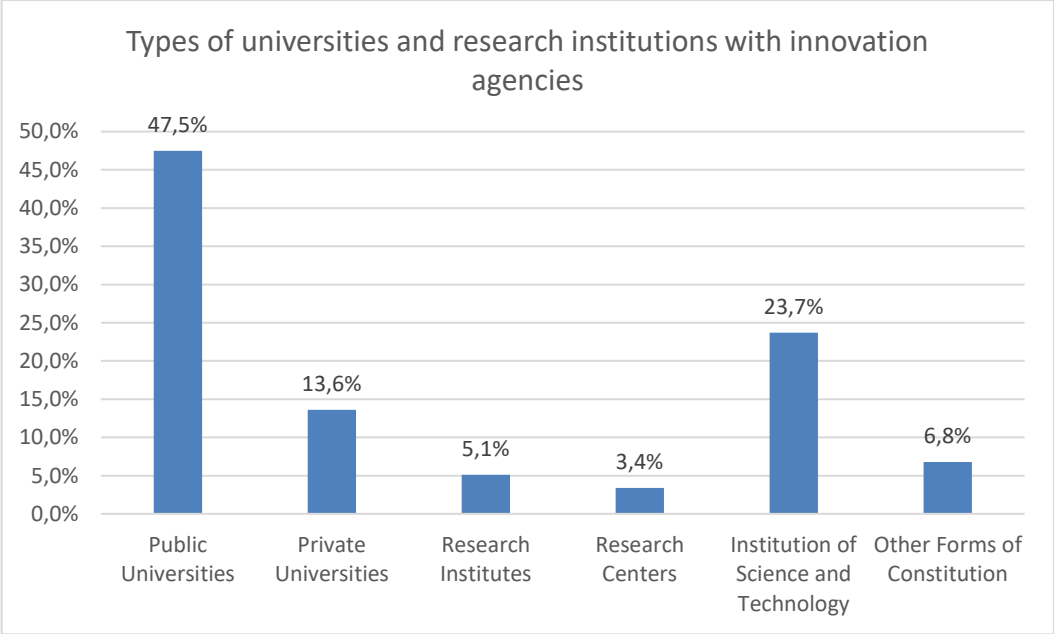
Business respondents also filled in which institution they are affiliated with, being 9% at ANPEI, 15% at ANPROTEC, 48% at other entities and 28% did not report. Regarding the revenues of these companies, 52% marked having up to R$ 500 thousand per year in revenues, 20% from R$ 500 thousand to R$ 2 million per year, 15% from R$ 2 million to R$ 10 million

per year and 13% declared revenues exceeding R$ 10 million per year. They were also asked how old the companies were, and 23% said they were 1 to 3 years old, 12% from 4 to 5 years and 65% over 5 years old.

Then, the profile of the interviewees or researchers from the companies was identified, with 75% males and 25% females. In terms of age, 31% marked being under 30 years old, 32% from 31 to 40 years old, 21% from 41 to 50 years old and 16% over 50 years old. Regarding the position, 76% are partners / directors, 15% managers and 9% employees.

The respondents from the innovation agencies also completed the questionnaire and, on the variable of which type of educational institution they belong to, Figure 3 presents this classification.

Figure 3 – Types of universities and research institutions with innovation agencies



Note: The percentages of the Innovation agency relate to a sample of 59 respondents.
Source: Prepared by the authors from SPSS version 20

Regarding the region of the institution, 6.8% are located in the North, 20.3% Northeast, 5.1% Midwest, 39.0% Southeast and 28.8% South. In terms of the profile of respondents from innovation agencies, 54.2% are male and 45.8% female. In relation to age, 11.9% are up to 30 years old, 37.3% from 31 to 40 years old, 22.0% from 41 to 50 years old and 28.8% over 50 years old. When questioned about the period of time they have been working at the innovation agency, 30% answered 2 years, 35% from 2 to 5 years, 27% from 5 to 10 years and 7% over 10 years. About their occupation the innovation agency, 39% are teachers, 37.3% are technicians,

3.4% are external collaborators, 5.1% are scholarship holders and 15.3% stated that they take on other roles in the agency.

With respect to types of innovation, the means, median, mode and standard deviation by the samples of the companies and innovation agencies were identified in order to detect the frequencies chosen in the seven-point Likert scale, as presented in Table 3.

Table 3 – Results of means, median, mode and standard deviation on the types of innovation in companies and innovation agencies presented in the survey

	Innovation Indicators 1 - Incremental Innovation		**Innovation Indicators 2 - Radical Innovation**		**Innovation Indicators 3 - Disruptive Innovation**	
	Companies	Agencies	Companies	Agencies	Companies	Agencies
Mean	5,46	5	4,59	4,02	4,30	4,08
Median	6	5	5	4	4	4
Mode	5	5	4	4	4	4
Standard deviation	1,234	1,083	1,464	1,225	1,521	1,179

Note 1: The percentages of the business relate to a sample of 100 respondents.
Note 2: The percentages of the Innovation agency relate to a sample of 59 respondents.
Source: Prepared by the authors from SPSS version 20.

As shown in Table 3, incremental innovation was the type that presented greater proximity as a continuous occurrence in corporate structures. Companies have found that their efforts for innovative action are more incremental and, as reported by Henderson and Clark (1990) and Markides (2006), can be related to processes for improving existing products and services. It is noticed that actions to increase already established products and services arise from the need to achieve short-term results, in which other more intense types of innovative research demand more time and uncertainty about market success.

However, the radical and disruptive innovation indices obtained a satisfactory number compared to the Likert scale, which demonstrates that companies and innovation agencies recognize the importance of acting in search of more radical or disruptive innovations in their market strategies, with a longer-term focus and more limited resources that, as noted by Jansen, Van den Bosch and Volberda (2006), may affect companies' short-term profit margins.

Table 4 presents the results on the intensity attributed to the concept of open innovation and how new forms of innovation are perceived as strategic by companies and innovation agencies.

Table 4 – Results of means, median, mode and standard deviation on the types of open innovation and new forms of innovation as a strategy

	IIN4-Open Innovation		IIN5-New forms of innovation as a strategy	
	Companies	Agencies	Companies	Agencies
Mean	4,13	4,58	5,39	5,10
Median	4	4	5	5
Mode	5	4	5	4
Standard deviation	1,368	1,163	1,091	1,255

Note 1: The percentages of the business relate to a sample of 100 respondents.
Note 2: The percentages of the Innovation agency relate to a sample of 59 respondents.
Source: Prepared by the authors from SPSS version 20

The results on the concept of open innovation are close to the satisfactory index because, despite being a recent concept in the literature and with still shy approaches in business structures, it begins as a consistent highlight in business strategies. Chesbrough (2003) notes the importance of discussing the external options of organizations as strategic and provides action plans to implement these strategies in business areas.

One point also presented in Table 4 was the average rate of new forms of innovation as a strategy. In fact, the average of respondents by companies was higher than those reached by innovation agencies. In many situations, this is an internalized perception in business organizations, but this indicator may not explain the reality of organizations if whether or not they have knowledge about how to innovate to obtain competitive advantage, as presented by Porter (1990).

In addition, the percentages of the answers to the questionnaires of companies and innovation agencies were identified, aiming to pinpoint the concentration on the Likert scale (Malhotra, 2011) of the questions answered, as shown in Table 5.

Table 5 – Results of percentages of responses of companies and innovation agencies by the Likert scale used in the survey

	Innovation Indicators 1 - Incremental Innovation		Innovation Indicators 2 - Radical Innovation		Innovation Indicators 3 - Disruptive Innovation	
	Companies	Agencies	Companies	Agencies	Companies	Agencies
1 – Never occurs	-	-	2%	-	3%	1,7%
2 – Very rarely	3%	5,1%	6%	11,9%	11%	5,1%
3 – Rarely	3%	3,4%	13%	23,7%	13%	25,4%
4 - Occasionaly	13%	13,6%	28%	27,1%	31%	30,5%
5 - Frequently	30%	45,8%	24%	27,1%	18%	27,1%
6 - Very frequently	28%	28,8%	15%	8,5%	16%	8,5%
7 - Always	23%	3,4%	12%	1,7%	8%	1,7%

Note 1: The percentages of the business relate to a sample of 100 respondents.
Note 2: The percentages of the Innovation agency relate to a sample of 59 respondents.
Source: Prepared by the authors from SPSS version 20.

According to data about the frequency of responses on the 7-point Likert scale cited in Table 5, a concentrated frequency in the enterprise sample of 81% in the options (5-frequently) to (7-always) for incremental innovation was identified, 67% in the options (4-occasionally) to (6-very frequently) for radical innovation, 65% in the options (4-occasionally) to (6-very frequently) for disruptive innovation.

The results for innovation agencies recorded frequencies of 88.2% in the options (4-occasionally) to (6-very frequently) for incremental innovation, 77.9% in the options (3-rarely) to (5-frequently) for radical innovation, 83% in the options (3-rarely) to (5-frequently) for disruptive innovation.

A greater concentration of responses in the option of incremental innovation is perceived in the companies (Henderson & Clark, 1990; Markides, 2006; OECD, 2005), which is also observed in innovation agencies when asked which type of innovation is most recurrent in university and company interactions.

However, there is also an important frequency of responses by companies in the indicators of radical and disruptive innovations and, less frequently in innovation agencies. This demonstrates the intense demands for disruptions in the marketing environment by business organizations with more disruptive products and services to overcome competition and obtain greater value attributes (Bower & Christensen, 1995; Christensen, 1997; Markides, 2006). In sequence, the results of the percentages of the companies and innovation agencies are presented in Table 6 by the Likert scale.

Table 6 – Results of percentages of responses of companies and innovation agencies by the Likert scale used in the survey

	Innovation Indicators 4 – Open Innovation		**Innovation Indicators 5 – New forms of innovation as a strategy**	
	Companies	Agencies	Companies	Agencies
1 – Never occurs	4%	1,7%	-	-
2 – Very rarely	8%	3,4%	-	-
3 – Rarely	18%	3,4%	2%	6,8%
4 – Occasionaly	27%	42,4%	19%	30,5%
5 – Frequently	32%	32,2%	39%	30,5%
6 - Very frequently	6%	10,2%	18%	10,2%
7 – Always	5%	6,8%	22%	22%

Note 1: The percentages of the business relate to a sample of 100 respondents.
Note 2: The percentages of the Innovation agency relate to a sample of 59 respondents.
Source: Prepared by the authors from SPSS version 20.

In Table 6, it was identified in the responses of companies about open innovation that 77% opted for (3-rarely) to (5-frequently) and, in the case of innovation agencies, 84.8% were

registered for options (4- occasionally) to (6-very frequently). Thus, open innovation (Chesbrough, 2003, 2006; Hall, Link, & Scott, 2001) was highlighted in the frequency of responses in both samples.

The last question was related to whether companies see it as strategic to look for completely new ways to innovate and the frequency obtained was that 98% on the (4-occasionally) to (7-always) options in the corporate sample and 93.2% on the options (4-occasionally) to (7-always) by innovation agencies.

This point is reflected in Fagerberg, Mowery and Nelson's (2006) approaches to incorporating the innovative process into their new product launch leverage strategies and Zien and Buckler's (1997) approaches to choosing an innovative culture for the company with emphasis on generating competitive advantage.

Tables 5 and 6 also show homogeneity among respondents of companies and innovation agencies within the Likert scale, which can be related as a direction of efforts to validate innovation actions. Antagonisms in the responses of the research actors in the presented items are not perceived, with the exception of those of radical and disruptive innovation that the innovation agencies had greater sharp difference for the item (3-Rarely) in relation to the companies and, in open innovation questions, that companies were markedly different from innovation agencies. However, if the answers are observed in their entirety, there is no significant divergence regarding the perceptions of respondents in the questionnaire items.

4.2 The perception of innovative models by innovation managers

In addressing the types of innovation most perceived in interactions of the Technology Innovation Nucleus (TIN), respondent E1 highlighted that the university does not control the types of innovation more recurrent in interaction with companies and research centers.

Nevertheless, it was reported by E1 that companies demand in the Technological Innovation Nucleus more incremental innovations. It was also observed by the interviewee that this type of innovation is not what TIN has in a protected and registered way, but it is the great demand of companies in search of increment of their already consolidated solutions. Henderson and Clark (1990) note that incremental innovation also has the ability to refine and extend an established design of a product or service in the marketplace, so companies are looking for improvement in something that is already settled in consumers.

In questioning interviewee E2 about the most recurrent innovative format in the daily life of the TIN, he commented that in the interactive relationships with companies occurs more

incremental innovations and the other formats, such as radical and disruptive, reach almost zero. The interviewee stressed that there is no interest on the part of business organizations for this innovation model in Brazil and, if any, on a minimal and timely scale.

Respondent E3 pointed out that the interest of the demands of companies that relate to the TIN is solving problems of existing products in their portfolios and increasing additional characteristics. Thus, there is no proactive interest in exploratory research in university laboratories.

When asked about the most recurrent type of innovation in the university-company interaction process, interviewee E4 commented that in the area of patents and technology licensing in his sector, radical innovations are more recurrent. The interviewee could not report in other areas of the TIN if other formats of innovation occur, but situations of demands from biotechnology companies that require incremental innovations to their projects under development were mentioned.

Respondent E5 reported that there are few disruptive innovations in Brazil, with companies having a greater ascendance for incremental innovations. Interviewee E6 commented that some radical innovations were recorded in the area of vaccines, but rarely occur because the most intense innovations are the incremental ones.

Finally, respondent E7 cited that, from 2015 to 2016, the TIN that participates recorded much of the demand for cooperation and technology transfer in incremental innovations. The interviewee reported that no demands were registered that can be characterized as radical and disruptive innovations. The OECD (2005), through the Oslo Manual, reports that innovation strategies are situational according to the level of competitiveness of companies in the markets and the defense of their competitive positions. In Brazil, the behaviour of incremental innovations may direct a competitive analysis of the market.

To sum up, the following synthesis of the most recurrent types of innovation in the NITs, according to the perceptions of the innovation managers and presented in Table 7, explain the innovations that were cited and not cited in the interviewees' statements.

Table 7 – Types of innovations cited and not cited by respondents

Types of innovations / interviewed	E1	E2	E3	E4	E5	E6	E7
Incremental innovation	Cited	Cited	Cited	Cited	Cited	Cited	Cited
Radical innovation	Not cited	Not cited	Not cited	Cited	Not cited	Not cited	Not cited
Disruptive innovation	Not cited	Not cited	Not cited	Not cited	Cited	Not cited	Not cited
Open innovation	Cited	Not cited	Not cited	Not cited	Not cited	Cited	Not cited

Source: Prepared by the authors.

From the interviewees, it is clear that, despite the fact that agencies of innovation and companies often relate to radical and disruptive innovations, these situations are occasionally reported with the concept of open innovation, as shown in Tables 3, 4 and 5, with reinforcement that the demands of companies are guided, in large part, by short-term needs and for specific solutions with a corrective focus and to meet regulatory requirements in the market, as stated by Interviewee E1. Another incipient concept in innovation managers and companies is that of open innovation (Chesbrough, 2003, 2006), in many situations configured as university-company interaction, cooperation and technology transfer.

However, licensing options between NITs and companies are still timid, with the potential to use open innovation as a strategy to intensify the process of knowledge and technology transfer.

5 Conclusions

The objective of this research, which was to present a survey of the types of innovation most pointed out by companies and innovation agencies in the interaction process, was achieved by collecting data from companies and innovation agencies to survey the type of innovation most recurrent in the university-business relationship. The types of incremental, radical and disruptive innovation (Henderson & Clark, 1990; Markides, 2006; OECD, 2005) and the open innovation option (Chesbrough, 2003, 2006; Hall, Link, & Scott, 2001) were identified and stratified, focusing on raising the levels that companies have to seek and absorb technology innovations externally. It was found that new forms of innovation as a strategic option was also presented (Teece, 1986; Damanpour, Szabat, & Evan, 1989; Lengnick-Hall, 1992; Rogers, 2003; Cantwell, 2006; Porter, 1990; Gupta & Trusko, 2014).

In summary, the results showed that incremental innovation was marked as the most recurring type, with averages 5.46 from companies and 5 from innovation agencies. Radical innovation followed, with averages 4.59 and 4.02, respectively. Finally, disruptive innovation

also achieved representative averages, with 4.30 and 4.08. Open innovation achieved a satisfactory average, companies with 4.13 and innovation agencies with 4.58. Thus, similarities and cohesion were identified in the indexes answered in both samples.

It was also observed that the different types of innovation permeate a conceptual and practical incorporation by the samples of companies and innovation agencies, with small responses covering options (1-Never Occurs) to (3-Rarely). As a result, the responses most focused on incremental innovations converge with Bower and Christensen (1995) and Christensen et al. (2016) on the perspective that the risks involved in disruptive innovations inhibit actions for this type, beyond the tendency of companies to seek technologies to sustain maintain better levels of performance in the short term.

As a theoretical implication of this research, the results expose the influence of innovation types to obtain competitive advantage in innovative projects. In the clipping of the methodological implications, it can be observed by the control variables answered that the profile of the respondents in both samples, companies and innovation agencies, can be considered satisfactory because it validates the results obtained.

In the interviews, there was a large occurrence of incremental innovation in the relations of the technological innovation nucleus and the companies, with few situations of the other types of innovation. According to the interviewees' report, there are rarely demands for radical and disruptive transformations in Brazilian university-company interactions. It should be noted that when there is involvement with patent generation, innovations are directed more for radicals.

As regards the limitations of the survey, the concentration of the answers from the samples of companies and innovation agencies, specifically in the South and Southeast Regions and, even though the questionnaire was sent to companies and innovation agencies located in several Brazilian regions, the return was concentrated in the regions above. Another limiting aspect was the need for expansion of respondents to better contextualize the meanings and applications of concepts of types of innovation, for example, the radical and disruptive.

In future surveys, the balance of respondents can be better planned with the aim of achieving a better distributed analysis throughout the Brazilian territory. The option of expanding the population of companies seeking interaction with the university for collaborative actions and technology transfer was also identified in the research. Through the use of methodological options such as case studies, situations of technology transfer projects that presented the most recurrent types of innovation can be observed.

In short, other suggestions for future research may be anchored in research on the way in which forms of innovation impact business results, by the presentation of a portfolio of products and services that originated in a specific innovative format. Another point of observation may also be fostered in identifying research paths on university campuses on inventions and their developments in an innovation process.

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