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An overview on actions to innovation in Brazilian universities

Panorama de ações de inovação nas universidades Brasileiras

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Abstract
The research presents the theme of open innovation and the prominent role that the university, as a scientific and technological research institution (ICT), should play in fostering partnership with market, intellectual property, entrepreneurship and incubation of companies. The general objective was to identify the innovation actions in universities and to analyze the national ranking related to the most innovative universities. The research followed a descriptive scientific methodological process, in which the subject of innovation in the universities and innovation actions in Brazilian universities were raised through documentary research. The results show that the culture of intellectual property and innovation in the country is not yet widespread, neither within the universities nor in the productive sector.
Keywords: open innovation; university; innovation actions.

Resumo
A pesquisa apresenta o tema da inovação aberta e o papel de destaque que a universidade, como uma Instituição de Pesquisa Científica e Tecnológica (ICT), pode ter no fomento de parceria com o mercado, propriedade intelectual, empreendedorismo e incubação de empresas. O objetivo geral foi identificar as ações de inovação nas universidades e analisar o *ranking* nacional de inovação universitária. A pesquisa seguiu um processo metodológico científico descritivo, e, por meio de pesquisa documental, foi levantado o tema da inovação aberta e possibilidades de ações nas universidades brasileiras. Os resultados mostram que a cultura de propriedade intelectual e inovação no país ainda é pouco difundida, tanto no âmbito das universidades como no setor produtivo.
Palavras-chave: inovação aberta; universidade; ações de inovação.

1 INTRODUCTION

De Negri (2018) demonstrated that the Brazilian innovation system is in countercurrent in several aspects when compared to the most innovative economy systems. In Brazil, the innovation system is little cohesive and the relationships among innovation agents are underexplored, especially between universities and companies. The country is poorly opened economically, limiting the access to foreign concurrence and to knowledge and technology transfer processes. Besides that, in a negative approach as well, the business environment is also complex, with excess of bureaucracies and reduced availability of options to enhance innovation financing. In

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addition, even though technological parks and incubators are under development across the country, another unfavorable point revealed by Abreu, Vale, Capanema and Garcia (2016) is that this occurs without homogeneity among regions, and that type of initiative represents support to enterprises in the initial stages, mainly in innovation hubs.

According to the study carried out by CDT/UnB (2014), 84% of Brazilian technological parks were concentrated in the south and southeast regions, which demonstrate that initiatives related to innovation are prevalent in regions which show higher economic relevance. Some determinant factors to the allocation of innovation clusters are the regional economic potential and the capacity of innovation management in the ICTs in the regions.

As an example, the Brazilian Association to Research and Industrial Innovation (Embrapii in Portuguese) promotes the development of applied research, development and innovation of federal educational institutes, and determines the focus of its innovation hubs based on such criteria. As stated by MEC (2017), the focus distribution concerning the knowledge area among federal institutes is as follows:

> 1.Santa Catarina - IFSC (Florianopolis Campus), Energy intelligent systems;
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> 2.Paraiba - IFPB (Joao Pessoa Campus), focused on manufacturing systems;
>
> 3.Minas Gerais - IF South of Minas (Machado Campus), coffee agroindustry;
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> 4.Goias - IF Goiano (Rio Verde Campus), which highlights the agroindustrial technologies as competence áreas;
>
> 5.Bahia – IFBA (Salvador Campus), focused on health technology;
>
> 6. Ceara – IFCE (Fortaleza Campus), embarked systems and digital mobility;
>
> 7. Espirito Santo – IFES (Vitoria Campus), metallurgy and materials;
>
> 8. Minas Gerais – IFMG (Formiga Campus), intelligent automotive systems; and
>
> 9. Rio de Janeiro – IFFluminense (Campos dos Goytacazes Campus), environmental monitoring and instrumentation.

The ICTs, as federal institutions, beside universities, they are the innovation ecosystems, which create a bridge between academy and market and play an important role in the social and economic development to the country. Thus, the scope of the research is Brazilian universities as research institutions and its actions towards innovation issues. The article shows the conclusion that while the foreign innovative potencies focus on opening their innovation models in order to be in synchrony with increasingly accelerated cycles of innovation, instead Brazilian Universities remain dormant in some aspects related to that new paradigm.

2 METHODOLOGY

The objective of the research was to investigate the possibilities of open innovation in Brazilian Universities and the methodological path applied was: (1) exploratory research through document analysis and subsequent synthesis; (2) practical research through questionnaires applied to the innovation departments of the HEIs; (3) synthesis of data in infographics; and (4) discussion about the innovation situation within the university. The article presents the results of the documentary research and a discussion on innovation actions.

3 INNOVATION IN THE BRAZILIAN UNIVERSITY

The United States, whose government strongly addresses policies to encourage the generation of innovation, hold several regions with a concentration of research and development combination between universities and companies, such as Silicon Valley in California. That classic example illustrates the successful application of the Open Innovation and

Triple Helix model, which represents the principle of business incubators. Toledo (2015) explains that the beginning of the US government's involvement dates from the period of Second World War, when it was created the first agency dedicated to scientific research and development to support military interest research within universities, the Office of Scientific Research and Development (OSRD), which was later dissolved in 1947. However, at the end of the war, federal funding and incentives were maintained and strengthened with the creation of new programs to the management of research and innovation activities, such as the remodeling of the National Innovation System (SNI) and the establishment of the National Science Foundation (NSF) and other national research institutions dedicated to a specific area.

Since the post-war period to the present day, US legislation has been incorporating more policies to ensure a favorable environment to research and innovation activities. Shapira and Youtie (2010) explain that the 1980s, when the US began to feel the economic impacts coming from the rise of the developing countries as its competitors, it was a milestone to the expansion of the country's legislation regarding innovation with emphasis on the implementation of the Bayh–Dole Act (The University and Small Business Patent Procedure Act), Stevenson–Wydler Technology Innovation Act and Small Business Innovation Development Act, which are intended to facilitate the interaction among the innovative agents (university-company), the intellectual property protection, as well as the application of private investment in embryonic companies.

Those circumstances made it possible to Stanford University, since the 1950s and 1960s, encouraging research and fostering the university-company link, and stimulating spin-offs and start-ups, which resulted in the formation of large clusters of laboratories and innovation centers of technology companies in its surroundings with initiatives from their students and alumni, and which, eventually, gave rise to Silicon Valley. Several of those companies with their great potential rose to success and became recognized such as Amazon, Apple, Facebook, Google, Hewlett-Packard, Microsoft, Yahoo!, among others. The fertility of Silicon Valley is visible concerning the patent registration numbers per 100,000 inhabitants, which, according to data from the US Patent and Trademark Office and the California Department of Finance (2018, apud Silicon Valley Institute for Regional Studies, 2018), increased from 476 to 596, between 2011 and 2018, providing an improvement of 25.1%. There were more than 1.6 million job openings, which were occupied in the second quarter of 2017, counting on rising statistics on jobs and wages since 2010, according to data from the four-monthly census of US Bureau of Labor (2017, apud Silicon Valley Institute to Regional Studies, 2018). In other words, those innovation clusters, such as Silicon Valley, are major contributors to the rise in the country's GDP, as they represent epicenters in generating knowledge, innovation and jobs.

The city of Boston embraces some of the most important universities, such as Massachusetts Institute of Technology (MIT) and University of Harvard, which were great institutional contributors to the prosperity of Route 128 in the 1970s. Toledo (2015) explains that MIT, in particular, it was the pioneer in encouraging entrepreneurship and technology transfer, and its mission is to develop business awareness alongside scientific research capabilities within the institution. Due to that fact, it has always kept large companies within its network, since the first half of the 20th century. Besides, MIT was an inspiration to Stanford University, which would later rode the Silicon Valley. The entrepreneurship fostered by MIT is also reflected in transformation of Kendall Square into a powerful innovation ecosystem in the 1960s. Adjacent to the

university's campus, Kendall Square comprises offices of major multinationals companies in the pharmaceutical, information and communication technology areas as well as local biotechnology corporations, such as Genzyme and Millennium.

Inspired by US universities, between the 60s and 70s, Sophia Antipoli technological park was established in France as the first European park, and Cambridge Science Park was founded by Trinity College as the first technological park in United Kingdom. Moreover, since then, initiatives to create technological parks near universities have been emerging all over the world, including in Brazil.

Concerning the national scene, State University of Campinas (Unicamp) could be highlighted, as its innovation agency, Inova Unicamp (launched in 2003), it is in charge of stimulating new Research and Development (R&D) partnerships among the university and the private and public sectors in order to assist its researchers in the innovation licensing processes, and to awaken the entrepreneurial spirit within the academic community through the offering of disciplines and programs about entrepreneurship. Inova Unicamp invests heavily in its Technology-Based Business Incubator (Incamp) and in its science and technological park, which houses innovation laboratories to conducting joint R&D activities.

Unicamp should be considered as one of the pioneers in developing the innovation relationship in an open model way, as its initiative preceded the sanction of the Innovation Law (Law nº. 10973/2004). Besides Unicamp, Federal University of Minas Gerais (UFMG) and Federal University of Rio Grande do Sul (UFRGS) are other examples, as they already had their Technological Innovation Centers (NITs) before the implementation of the Innovation Law, and they ended up serving as a model to others that by any reason were not yet following the law. The law nº. 10973/2004 contemplates incentives to the production of innovation and scientific research, and previews the NITs to manage innovation activities in the Scientific, Technological and Innovation Institutions (ICTs) along the country. The ICTs are bodies of public or private administration that conduct the scientific and technological research or the development of new products and services, which means, the involvement of universities and research institutions. Toledo (2015) emphasizes that it is quite advantageous, in terms of efficiency and effectiveness, that the teaching and research missions in the universities should be in accord with the activities enrolled in the production of innovation, such as collaborations with companies, the knowledge transfer and incentives to entrepreneurship.

Since the NITs introduction in the ICTs, the interactions between the university and other agents that form the Brazilian SNI began to be more explored, although it is still an emerging system. That justifies the challenging scenario to open innovation initiatives in Brazil, when compared to United States, which has a SNI already developed and very robust.

The relatively late involvement with innovation in Brazil is a consequence of its equally slow industrial, financial and, above all, academic development, as revealed by Suzigan and Albuquerque (2008). The formation of an expressive Brazilian scientific community comes from the mid-twentieth century, as well as the creation of the two main entities to promote and support scientific and technological research, the National Council for Scientific and Technological Development (CNPq) and the Coordination to the Staff Improvement in Higher Education (Capes), both founded in 1951. In 1985, the current Ministry of Science, Technology and Innovations and Communications (MCTIC) was conceived.

Nevertheless, in a short period from the emergence of the scientific community

to the arriving of the 21st century, there was a public effort movement in order to cultivate and add significant values to SNI, precisely due to the manifestation of new demands coming from that recent segment and the need to meet them. One of the first products that arised from that impulse was the Financier of Studies and Projects (Finep), a public agency financing innovation and research that is linked to the MCTIC, which in 1967, came to increase the Technical-Scientific Development Fund, created in 1964, by the National Bank to Economic and Social Development (BNDES). Another one that should be mentioned is the Human Resources Training Program in Strategic Areas (RHAE), which was born in 1987 from the partnership between MCTIC and CNPq, and offers various types of scientific and technological development scholarships aimed to R&D activities in micro, small and medium-sized companies, focusing on training human resources to conduct projects in applied research.

There are also private initiatives, such as Brazilian Micro and Small Business Support Service (Sebrae) and Industry System. Since 1972, Sebrae has encouraged the market competitiveness and provided opportunities to the sustainable development in small businesses by offering training programs and enabling access to credit in association with banks and credit cooperatives. Besides, Industry System is a private network comprised by National Confederation of Industry (CNI), National Service to Industrial Learning (SENAI), Social Service to Industry (SESI), and Euvaldo Lodi Institute (IEL), which promote training programs and encourage competitiveness, research activities and innovation in the industrial sector.

At the beginning of 2000s, other key points stand out and contributed to leverage the Brazilian SNI. Those key points were the sanctions of Law on Innovation (law nº. 10973/2004) and the Law of Good (law nº. 11.196/2005). Law of Innovation includes incentives to joint R&D activities between universities and companies, and regulations on technological parks and incubators. While Lei of Good proposes tax incentives to legal entities related to innovation activities, such as expenses with R&D and patent registration.

Marzano (2011) emphasizes that such laws were created to eliminate obstacles in the establishment of partnerships between universities and companies, but there seems to be some mistrust between those two agents. The author mentions that within Brazilian universities there is a certain dichotomy between applied and pure research, and that academic productions often provide no practical applications; while the productive sector is interested in the practical value of applied research. Therefore, Stal and Fujino (2005) suggest a reconciliation between universities and companies through the transformation of academic culture and values. Foray and Lissoni (2010) argue that there is complementarity between the capacities of universities and companies in an R&D partnership, since the two agents allow themselves to explore their respective qualities in a most profitable way, and that cooperation represents a series of economic opportunities.

According to the literature about university-industry partnerships in R&D, as well synthesized by Mowery and Sampat (2005), companies could benefit from the concentration of human capital and scientific and technological knowledge in the universities, and take advantage from the infrastructure they possess in order to develop prototypes to their products. Furthermore, in collaboration with universities, companies could enrich their repertoires and raise their innovative potential through the dissemination of knowledge.

The university-enterprise partnerships are beneficial to universities as much as to companies in the sense of providing opportunities to the development

of innovative projects, which in the past would be missused within university boundaries. Furthermore, Lee (2000, apud SALOMON and SILVA, 2007) points out that the collaborations represent a means of expanding resources to the academic research and research infrastructure, to investigate the practical applications of research and to absorbe practical knowledge to teaching. The proximity to the business sector also represents opportunities of internship and employment to undergraduate and graduate students, which enriches the academic repertoire of students and contributes to the training of more qualified professionals focused on the job market. Moreover, the innovations from research contribute to the involvement of universities in patent registration activities, as well as increase the volume of scientific publications.

In addition to the mutual benefits generated from the relationship between universities and companies, the products from that partnership between those innovation agents contribute to the socioeconomic development of the country. As a matter of interest to the State, its function is to develop policies to strengthen university-industry interaction. The State must also act as a catalyst and facilitate that interaction, eliminating the excess of bureaucracy within universities, as Gonçalo and Zaluchi (2011) expose, as this seems to be one of the biggest obstacles between universities and companies. The State must provide resources in order to improve the research structures in the public universities to make them more attractive to companies interested in establishing partnerships. In addition, it is an advantage to invest in innovation ecosystems, such as incubators and technological parks in order to operate near university campus, and thus enhance the university-industry bond. It should be noted that the participation of the state in innovation cycles should not necessarily happen only in an indirectly form; the public sector could maintain R&D partnerships with universities and research institutions through state-owned companies.

Santos (2011) describes a successful and lasting example of a case of R&D partnership between university and company: Federal University of Santa Catarina (UFSC) with Brazilian Company of Compressors (Embraco in Portuguese). Embraco, which was dependent on technology imported from a Danish company until the 1980s, sought its technological emancipation by signing an agreement with the Department of Mechanical Engineering in UFSC in 1982. Research in partnership with the laboratories in UFSC not only ensured independence concerning imported technology as it raised the company to a competitiveness environment, pushing it to the world leader in the field of hermetic compressors to refrigeration. Due to the importance that the company shows in that scenario, Embraco currently conducts research in partnerships with various entities in the public and private sectors, inside and outside the country.

As a second example to illustrate another successful case related to university-company partnership and to show the role of incubators in innovation cycles, it is about ANS Pharma, a spin off company linked to the State University of Campinas (Unicamp). Today, as a graduated company, ANS Pharma maintains research projects in partnership with universities and other companies, and it is supported by entities dealing with research promotion such as the National Council for Scientific and Technological Development (CNPq) and the Foundation for Research Support of the State of Sao Paulo (FAPESP). Through some partnerships, the company develops, sells and makes available to licensing, medicines and innovative technologies, which contribute to improve the people life quality with diabetes.

Besides, a third case, described by Almeida, Correia and Soares (2017), and by the 2008 - 2010 Report of Management

Activities (Embrapa Grape and Wine, 2010), demonstrates the State as a direct agent in the innovation process, pointing out the partnerships maintained by Embrapa Grape and Wine with universities and research centers.

Since the beginning, Embrapa has strived to develop new techniques and management of vines, dealing also with genetic improvements to ensure the vines better adaptability to different climatic conditions, and thus reduce geographic limitations to the grapes cultivation and improve the crops quality. Besides, in the agricultural sector, the technological transfers, especially in biotechnology and genetics areas, which come from universities and research institutions are valuable to generate innovation and maintain the competitiveness. In addition to the Brazilian Grapes Program, the institution is dedicated to other innovative projects, such as the Technological Innovations Project to the Modernization of Apple Sector (InovaMaça). The InovaMaça Project researcher team came from the partnerships established with other Embrapa units, also with another public company: Agricultural Research and Rural Extension Company of Santa Catarina (Epagri), University of Sao Paulo (ESALQ/USP) and State University of Santa Catarina (UDESC). According to the 2008 - 2010 Embrapa Management Activities Report, the outcome concerning scientific production related to that project was about 14 articles published in journals, 85 abstracts sent to scientific events and 12 articles showed in newspapers and magazines.

Embrapa Grape and Wine also coordinates the Institutional Program of Scientific Initiation (PROBIC) aimed at undergraduate students from universities that are affiliated to the institution. PROBIC is provided with scientific initiation scholarships granted by funding institutions such as the National Council to Scientific and Technological Development (CNPq) and the Foundation to Research Support of Rio Grande do Sul State (Fapergs). According to the 2008 - 2010 Management Activities Report, in 2010, 15 scholarships were approved, the highest number in the whole history of the institution. It is noteworthy to mention that projects developed in programs such as that one stimulate the scientific thinking, enrich the students' repertoire, which ends up increasing the probability of approval towards further academic specialization, and contribute to the professional training focused on research studies.

Rapini *et al*. (2009) show that in the sectors in which Brazil has competitive advantages in the world economy, the relationship between research and productive structures and the State was quite important. In that way, it could be mentioned the partnerships between Oswaldo Cruz Institute and Butantan Institute (the health sciences area); Embraer - Aerospace Technical Center (CTA) and Technological Institute of Aeronautics - ITA (aeronautical engineering area); and Federal University of Rio de Janeiro (UFRJ), State University of Campinas (Unicamp) and Petrobras (geosciences field).

Those mentioned cases corroborate to Chesbrough's arguments (2003) about the advantages in the Open Innovation model, as the production and diffusion of innovation are intensified due to the interaction along different agents in R&D activities. As Pinho (2018, p.35) explains, "although the central locus of productive innovation in market economies has been the company, there is the recognition that innovative firms should not rely exclusively on its internal competences". Therefore, partnerships counting on universities and research institutions come to fill some failures in the internal capacities of the companies, as well as to increase their human capital. Concerning the research structures, the knowledge transfers from those interactions are also beneficial, especially to universities, as the proximity to companies has great value to

the formation of highly qualified human resources. That is translated by the increasing in academic production at universities involved in partnerships with companies, in the number of articles published and the generation of master's dissertations and doctoral theses.

3.1 As universidades mais inovadoras do Brasil em 2017 e 2018

Folha de S. Paulo newspaper annually publishes a general ranking of Brazilian universities and another five specific rankings to each of the evaluation parameters related to research, internationalization, innovation, teaching and market. The information used in the construction of the rankings is collected from Datafolha annual surveys, as well as from Inep-MEC Census of Higher Education databases, Enade, SciELO network, Web of Science, Inpi, Capes, CNPq and other research funding institutions.

Concerning that work research, the 2017 and 2018 rankings related to research and innovation of universities were consulted (those last two editions were published). Those two parameters were considered the most relevant to establish a more effective cause-and-effect relationship, along the research and extension and innovation initiatives adopted by universities and their respective rankings.

Regarding the universities classification in terms of research quality, the indicators considered were: total of publications, total of citations, average of citations per article, average of publications per professor, average of citations per professor, total of publications in national magazines, the average of resources received by institution, the percentage of productivity grants by CNPq and the total number of theses defended by the faculty team. Such numbers always refer to years prior to the publication.

From 2017 to 2018, it is noted that the top 10 in the ranking concerning research quality remains exclusively composed by the public institutions, observed only a few alternations between universities. Both rankings remained led by Sao Paulo triple team composed by University of Sao Paulo, State University of Campinas and Federal University of Sao Paulo, which are recognised as great exponents due to their volume of publications and successful in conducting and developing research programs and extension. The Brazilian universities ranking according to research performance presented in Research in Brazil report, based on collected data from 2011 and 2016, and prepared in 2017 by Clarivate Analytics to Capes, it corroborates with some points showed by the university research quality rankings perfomed by Folha de S. Paulo. As Chart 1 presents, University of Sao Paulo also emerges as a leader in the number of publications, corresponding around 20% of the total academic production in the country according to the survey carried out by Clarivate. It should also be noted that the remainder of the top 10 is basically made up by the same institutions indicated in Folha de S. Paulo.

Chart 1 - Ranking of theTop 10 Brazilian universities related to research performance in 2017

NOME DA INSTITUIÇÃO	Nº DE PUBLICAÇÕES na base de dados Web of Science	% ARTIGOS NO TOP 10	% COLABORAÇÃO UNIVERSIDADE-INDÚSTRIA	% COLABORAÇÃO INTERNACIONAL
Universidade de São Paulo (USP)	54.108	7,96	0,83	35,83
Universidade Estadual Paulista Júlio de Mesquita Filho (Unesp)	20.023	6,10	0,30	27,77
Univesidade Estadual de Campinas (Unicamp)	17.279	8,35	1,11	30,57
Universidade Federal do Rio de Janeiro (UFRJ)	16.203	8,18	1,85	38,70
Universidade Federal do Rio Grande do Sul (UFRGS)	14.611	6,76	0,98	30,39
Universidade Federal de Minas Gerais (UFMG)	13.294	6,24	0,90	31,22
Universidade Federal de São Paulo (Unifesp)	10.667	6,15	1,24	28,78
Universidade Federal do Paraná (UFPR)	8.233	5,31	0,84	27,45
Universidade Federal de Santa Catarina (UFSC)	7.908	6,79	1,09	32,41
Universidade do Estado do Rio de Janeiro (UERJ)	6.433	8.98	1,04	39,33

Source: Adapted from *Clarivate Analytics* and Capes, *Research in Brazil 2017*

Institution name, Publication number (Web of Science data base), Top 10 articles porcentage, University-Industry collaboration porcentage, International collaboration porcentage
University of Sao Paulo (USP)
Julio de Mesquita Filho State University of Sao Paulo (UNESP)
State University of Campinas (UNICAMP)
Federal University of Rio de Janeiro (UFRJ)
Federal University of Rio Grande do Sul (UFRGS)
Federal University of Minas Gerais (UFMG)
Federal University of Sao Paulo (UNIFESP)
Federal University of Parana (UFPR)
Federal University of Santa Catarina (UFSC)
State University of Rio de Janeiro (UERJ)

However, Clarivate Analytics incorporates different parameters from Folha de S. Paulo to build its ranking and, therefore, the same universities have different rankings in the two surveys. Two variables considered by Clarivate Analytics, which are very interested to that work research: the collaboration index with the productive sector and the universities international collaboration index.

Although, University of Sao Paulo leads the ranking in absolute publication numbers, the institution is overlapped by its successors in relation to the percentage of partnerships with the industry sector. In this sense, Federal University of Rio de Janeiro stands out and shows 1.85% of its scientific articles production carried out in partnership with the productive sector. Clarivate Analytics indicates that this is due to the long-lasting relationship that those Rio universities maintain with Petrobras, which frequently presents itself as a co-author in their publications. Regarding internationalization, there is little disparity among the top 10 universities, which, in general, presents publications between 30% and 40% with foreign co-authorship. However, State University of Rio de Janeiro, once again Federal University of Rio de Janeiro and University of Sao Paulo, stand out. Federal University of Santa Catarina comes soon after, appearing as the fourth among the institutions that make up the top 10.

Concerning innovation production by Brazilian universities, Folha de S. Paulo adopted different assessment methodologies in 2017 and 2018. The 2017 ranking classification followed the number of patents applied by universities from 2006 to 2015. In 2018, Folha de S. Paulo incorporated one more component of innovation assessment in universities; the partnership with companies, which was demonstrated through the publications by the university in collaboration with its partnerships to Web of Science journals from 2011 to 2015. The universities ranking is defined by the innovation indicator in a scale from 0 to 4 according to their performance in the evaluation components. Charts 2 and 3 correspond, respectively, to the rankings of Brazilian universities by innovation indicator in 2017 and 2018.

Chart 2 - Ranking of Brazilian universities related to innovation indicator in 2017

POSIÇÃO EM 2017	NOME DA INSTITUIÇÃO	UF	PEDIDOS DE PATENTES	INDICADOR DE INOVAÇÃO
1°	Universidade de São Paulo (USP)	SP	1°	4,00
2°	Universidade Estadual de Campinas (Unicamp)	SP	2°	3,97
3°	Universidade Federal de Minas Gerais (UFMG)	MG	3°	3,94
4°	Universidade Federal do Paraná (UFPR)	PR	4°	3,91
5°	Universidade Federal do Rio Grande do Sul (UFRGS)	RS	5°	3,88
6°	Universidade Federal do Rio de Janeiro (UFRJ)	RJ	6°	3,85
7°	Universidade Estadual Paulista Júlio de Mesquita Filho (Unesp)	SP	7°	3,82
8°	Universidade Federal de Santa Catarina (UFSC)	SC	8°	3,79
9°	Universidade Federal da Bahia (UFBA)	BA	9°	3,76
10°	Universidade de Brasília (UnB)	DF	10°	3,73

Source: Adapted from Folha de S. Paulo newspaper, 2017 Folha Academic Ranking
Position in 2017 Name of institution Federal Unit Patents requests Innovation Indicator
1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th

Chart 3 - Ranking of Brazilian universities related to innovation indicator in 2018

POSIÇÃO EM 2018	NOME DA INSTITUIÇÃO (Instituições privadas sinalizadas com *)	UF	PEDIDOS DE PATENTES	PARCERIAS COM EMPRESAS	INDICADOR DE INOVAÇÃO
1°	Universidade Federal do Rio de Janeiro (UFRJ)	RJ	6°	6°	3,87
2°	Universidade Federal do Paraná (UFPR)	PR	4°	30°	3,59
3°	Universidade Estadual de Campinas (Unicamp)	SP	2°	35°	3,56
4°	Universidade Federal de Minas Gerais (UFMG)	MG	3°	34°	3,55
5°	Universidade Federal de Viçosa (UFV)	MG	18°	21°	3,51
6°	Universidade de Caxias do Sul (UCS)*	RS	26°	13°	3,50
7°	Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS)*	RS	22°	20°	3,46
8°	Universidade de São Paulo (USP)	SP	1°	48°	3,40
9°	Pontifícia Universidade Católica do Rio de Janeiro (PUC-RIO)*	RJ	36°	10°	3,39
9°	Universidade Federal de Pernambuco (UFPE)	PE	10°	39°	3,39
11°	Universidade Federal de Itajubá (UNIFEI)	MG	44°	4°	3,35
12°	Universidade Federal do Rio Grande do Sul (UFRGS)	RS	5°	53°	3,28
13°	Universidade Federal da Bahia (UFBA)	BA	9°	50°	3,27
13°	Universidade Federal de Santa Catarina (UFSC)	SC	11°	47°	3,27

Source: Adapted from Folha de S. Paulo newspaper, 2018 Folha Academic *Ranking*
Partnerships with companies
Private Institutions marked with*
11th, 12th, 13th
22nd, 53rd

There was a kind of realocation in the educational institutions group ranking concerning the addition of the evaluation criterion referring to partnerships with the productive sector (the core of the open innovation model within the university) as an indicator of the involvement of the universities with innovation. Note that the top 10 of 2018 includes University of Caxias do Sul, Pontifical Catholic Universities of Rio Grande do Sul and Rio de Janeiro, three private institutions that demonstrate their innovation productivity beyond patent requests and surpass entities that once dominated the top of the rankings.

University of Sao Paulo and University of Campinas, which topped the ranking in 2017 with maximum innovation indicators or very close to the maximum, they were displaced in 2018, and they were in the eighth and third places, respectively. Moreover, the 2018 ranking points to Federal University of Rio de Janeiro as the most innovative, with an indicator of 3.87 due to the balance between its rankings related to the number of requested patents and partnerships with the productive sector.

All those rankings reveal the complexity of measuring the innovation production within universities, since there is a series of interconnected variables. Those variables are beyond the ones directly related to innovation processes, such as registration activities. It is noticed that research performance, which encompasses factors such as publication volume, publication impact, partnerships with the productive sector and international partnerships, it has a significant impact on the innovation in an institution. That awakens the interest in investigating, deeply, how innovation management has been done in universities identified as the most innovative in the country in 2017 and 2018.

3.2 Innovation Management within Brazilian Universities

Public or private entities, which show as institutional mission, basic or applied research count on a scientific or technological nature, such as universities and research institutes, they are called ICT by the Constitution. The Innovation Law (law nº. 10.973/2004) establishes that every public or private ICT in the country that is benefited by the government must implement its own Technological Innovation Center (NIT) or share a NIT with another ICT in order to assist the management of its innovation policies. Torkomian (2009) states that although the legislation calls the structure responsible for managing innovation in ICTs as Technological Innovation Nucleus, there is a diversity of nomenclatures. One of the reasons for that is that some ICTs already had innovation management structures in place before the Innovation Law was enacted. In that way, NITs should have been designated as agencies, coordinations, board of directors, secretariats, among other variations.

The ICTs benefited by the government have the duty to complete, annually, the Formict (Form to Information on the Intellectual Property Policy of Scientific and Technological Institutions in Brazil), so that the Ministry of Science, Technology and Innovations and Communications (MCTIC) could monitor the NITs internships implementing and ensuring their alignment with the Innovation Law. According to the Formict made available by MCTIC in 2017, among the 208 ICTs, 74.8% have NITs already implemented, 16.6% have NITs in the implementation phase and in the remaining 8.6% there is no NIT implemented.

According to a survey published by the National Forum of Innovation and Technology Transfer Managers (FORTEC) in 2018, concerning NITs, three is the median number of full-time employees and two is the median number of part-time

employees. The survey shows that among employees with full dedication, the predominant level of academic training is master's degree, and regarding the level of training of those employees in management and innovation, it is highlight that 22.2% have previous experience in the productive sector, 9.8% have work experience in startups and 6.7% have experience in creating startups. Concerning part-time employees, 10.3% have previous experience in the productive sector, 5.6% have work experience in startups and 3.1% have experience in creating startups, and the majority possess doctorate degree.

Regarding hiring and training staff, a former FORTEC survey mentioned by Torkomian (2009) reveals that 77% of NITs mentioned those aspects as their main deficiencies. The majority declared to have less than 10 employees, as well as they believed that there was a lack of skills in technology transfer and a culture abscense related to intellectual property protection within their NITs. In that sense, Toledo (2015) states that NITs staff composition in Brazilian ICTs, especially in universities, contrasts with the ones in abroad. That occurs because, at each term, most NITs in Brazilian universities is coordinated by professors chosen by the dean, and they often have few experience in management and innovation areas. Added to that situtation, there is a high number of temporary employees, such as scholarship holders, interns and service providers. That management model represents one of the great weaknesses in Brazilian NITs, as those temporary teams with low professional experience in market and management turn their projects and activities more expose to discontinuities. Among programs and training courses in innovation management and intellectual property to overcome that gap, one could mention those offered by entities such as Inpi, World Intellectual Property Organization (WIPO), FORTEC, Anpei and Anprotec, and by NITs regional networks as well.

NITs have the duty to manage institutional policies to encourage innovation within ICTs. The NIT must monitor the processing of requests for intellectual property protection, foster partnerships between ICT and the productive sector, and manage the innovation transfer processes generated by ICT too. In that sense, Lotufo (2009) suggests that NITs could be characterized in three axes: legal, administrative and business-oriented. In addition, it reveals that ICTs look for, as much as possible, to match the NITs management model to business models. Thus, once again, it is reinforced the need to hire qualified professionals to work in the management and innovation areas in order to compose the NITs work team.

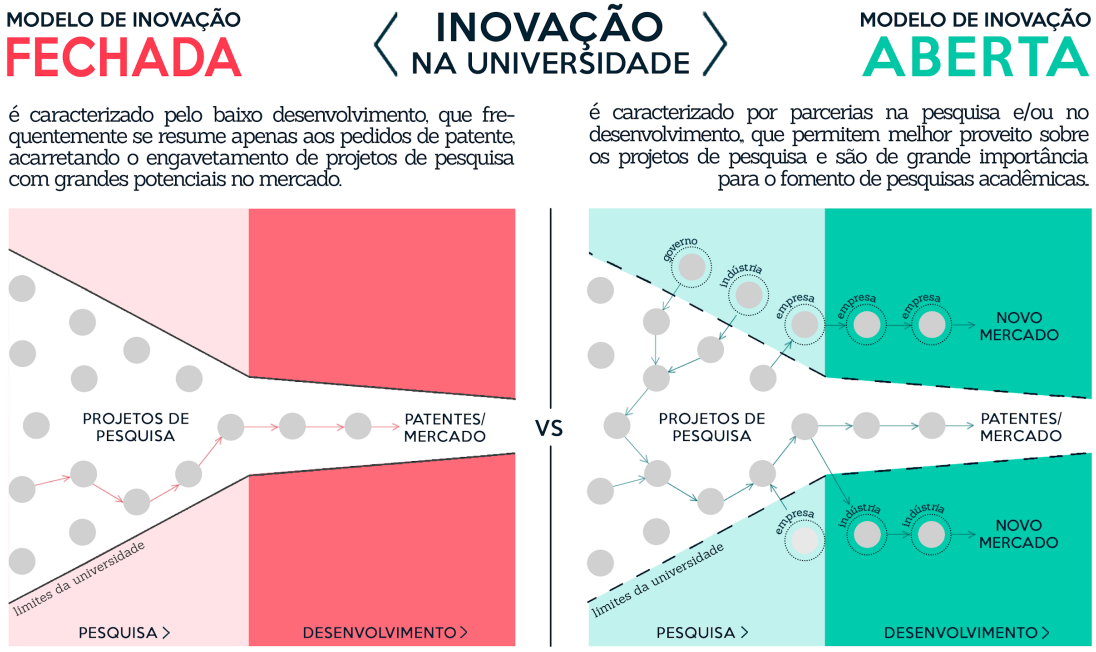
According to FORTEC (2018), in 2016, the average number of requests to intellectual property protection of Brazilian ICTs by NITs was 145.9, however, the median value was 41. Which means that the involvement in intellectual property protection activities occurs not so homogeneously among NITs, with a few ICTs more engaged in innovation, which end up raising the national average. Among the intellectual property protection activities coordinated by the NITs, there are the petitions to patent registration, computer program registration, trademark, utility model, industrial design, and copyright, among others. The study also demonstrates that there is a small portion among the cited ICTs that filed valid patent applications on abroad.

“Intellectual property becomes an element of relevant importance to socioeconomic development as long as the technological innovation occupies a central role in the competitiveness among countries, which are operating in a globalized scenario” (AMORIM-BORHER et. al, 2007, p.283). However, Toledo et. al (2009) highlight that the culture of intellectual property and innovation in the country is still not widespread, both within universities and in the productive sector,

and that the dissemination of that culture is quite value concerning the advantages of the social benefits innovation. Added to that, the incipient entrepreneurial culture in Brazil, revealed by Machado, Sartori and Crubellate study (2017), which hinders the integration between academia and the productive sector and configures the national scenario as a quite challenging ecosystem to the innovation activities. Although, their presence and importance are little recognized within the corporate environment, and within the academic community itself as well, the NITs represent an important agent in the process of building an intellectual property culture, innovation and entrepreneurship in the country.

A suggestion to make a University opener could be seen in Figure 1, which shows a comparison between Closed and Open Innovation within University.

Figure 1 - Open Innovation in University



Source: the author

Closed Innovation Model = it is characterized by a low development, which is often restricted to patents requests. As a result, there is a misuseful of research projects count on great market potential innovation.

Projetos de pesquisa = Research projects; Patentes/Mercado = Patents/Market; Limites da Universidade = Limitation of the University; Pesquisa = Research; Desenvolvimento = Development

Innovation Model

Open Innovation Model = it is characterized by partnerships in research work and/or in development, which provide better results in terms of research projects and they are quite importante to support academic research.

Novo mercado = New Market; Governo = Government; Indústria = Industry; Empresa = Company

The closed innovation is characterized by research projects conducted by researchers within their own research groups, without any partnership with the market due to the high level of bureaucracy involved and because of the

lack of market professionals. Thus, the results from that process are the production of research reports, scientific articles and few patent records, which could offer some market potential. On the other hand, concerning an open model, the research work and the partnerships along companies would take place freely in order to generate knowledge and exchange information during the development of the research so that robust results to the potential innovation should be directed to the market. Focusing on that, it is necessary that the NITs of Brazilian universities could be coordinated by professionals with experience in the management and innovation areas rather than professors appointed by the rectors and subjected to a change in staff at each term.

CONCLUSION

Companies could benefit from the concentration of human capital and scientific and technological knowledge in the universities, and take advantage from the infrastructure they possess in order to develop technologies, products and services. The current open innovation national scenario in the universities, when compared to countries, which lead in innovation approaches, it indicates the necessity of heavy investment to improve the innovation culture within those colleges in Brazil. The research showed that the knowledge about intellectual property and innovation in the country is little practiced, neither in universities nor in the productive sector, and that the sharing of that culture is really fundamental taking in account the innovation advantages to the social benefits. In addition, it is also worth to point out the requirement in hiring trained professionals to work in the management and innovation area, and to compose the NITs' working team together with the professors, as experts, who should leverage the knowledge generated in the universities, and push the research work conducted in that sphere to become market products in order to offer benefits to society.

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