Innovation, intellectual property and technological transfer by inventors in Brazil

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ABSTRACT

Innovation can be understood as a technological asset in relation to the protection of knowledge with regard to intellectual property, and a challenge for universities and companies regarding the transfer of technology, since there are numerous variables that influence even full monetization. It is important to reflect on all the energy expended in relation to the authors involved in this process, having as general aim to analyze the perception of researchers about the processes of protection of intellectual property and its security mechanisms, characteristics of innovation and technology transfer. A structured research was used as a methodology, using the survey method, applied to specialists, with hypotheses formulated, based on the literature review. The results mainly understand that there is a moderate correlation index in quantitative terms of graduate programs and number of patents, by region of Brazil, an awareness in agreement with the elements of protection of intellectual property. In global efforts among researchers, universities and companies, only about 5% of patents have reached the level of royalty generation, demonstrating that the other 95% are still available for potential exploitation for society.

Keywords: Technology, Triple-Helix, Patent.

o Introduction

Innovation is a process that involves the use, application and transformation of technical-scientific knowledge related to the production and commercialization of products or services with profit vision (HAUSER *et al.*,2015), and can be applied in processes and marketing (OECD, 2005), present with degrees of innovativeness at different levels (PINTO; THOMANN; VILLENEUNE, 2016), undergoing modifications due to decrements or increments to the object of innovation, or none of them, resulting from total disruptiveness (BAIYERE; HUKAL, 2020).

Each scientific research has an element of novelty and it is necessary to be aware about the importance of intellectual property protection (IP) regarding the new parts of the research, regardless of the degree of training of the researcher (SĂVESCU, 2020).

As for the aspects of intellectual property, innovation can be seen as a technological asset in the face of knowledge protection, verifying as a challenge the valuation in aspects of technological transfer between University-Company, since there is a complex number of variables and methods to be considered in the transformation of knowledge into *royalties* (CARVALHO *et al.*,2019; CHUKHRAY, MRYKHINA, 2020).

Negri (2018) commented that the greatest relevance to society regarding the appropriation of knowledge and the production of patents produced by universities to companies, is the avoidance of deposits of technologies that are not technically developed. And at this point, questions arise regarding the number of patents that are produced in a sample of Brazilian researchers-inventors, belonging to research groups, which are being developed in *network* with companies and other national and foreign inventors. As well as other questions, such as: What is the flow in technological transfer and royalties production? What are the perceptions about aspects of innovation, intellectual property and technological transfer for this group?

In seeking to answer these gaps, 84 specialists participated, involved in the areas of engineering and participants in technological processes of patenting in Brazil, consulted by *the survey* method, supported by the measurement of perceptions in the Likert gradual scale (1932) with sample calculation based on Fisher (1936).

Therefore, based on aspects of the knowledge economy in which there is detachment of energy and time from a thinking mass of researchers, it becomes relevant to understand the perceptions about the protection of intellectual property, possible security mechanisms protection, attributes of innovation and technological transfer, as well as to understand their participation in the framework of federal university institutions in Brazil and their respective graduate programs.

o Theoretical framework

This part aims at further deepening the theme, seeking to verify or structure constructs of the model, such as: protective elements (PE), sources of knowledge to innovation (HR), security mechanisms (MS), hybrid attributes to innovation (AH) and technological transfer (TT).

- Protective Elements (EP)

In the case study of Gonçalves and Tomaé (2020) at the Federal University of Paraná, in relation to the protection of knowledge applied to intellectual property, the authors identified that aspects such as the issue of secrecy, the search for technological information, confidentiality agreements, norms regarding publication and patenting, are not included in the guidelines for the protection of knowledge of that institution. They concluded that the absence of these guidelines may interfere in the sensitization of researchers to the protection of knowledge and innovation.

Another case study considered was that of mechanical engineering, from Romania, on the importance of promoting knowledge of IP in universities, but without current full application (SĂVESCU, 2020).

Oppenheim (2020) presented the role of copyright in the area of intellectual property, mentioning the strong influence it exerts on information to the student public, library professionals, and those who give lectures, write or use bibliographic resources, regardless of electronic or printed means, as well as the impact on those who serve the academic community, as funders and publishers.

Therefore, observing that researchers-inventors are professionals who must respect the copyright legal principles (BRASIL, 1998) and that when they carry out research aimed at technological innovation, they present the finalistic of technology transfer, they must respect the right to industrial property (BRASIL, 1996), so it is understood that:

EPa Every researcher or inventor generating innovations should know about the protection mechanisms.

In the between publishing or protecting, there is a third known as defensive publication, a modality that denotes the publication of an invention for the purpose of creating the state of the art, and thus preventing the granting of patents on this invention, despite the patent system itself being frequently used (HENKEL; PANGERL, 2008).

Shyam (2014) argued that defensive publications are effective means of defending intellectual publications, making the hypothesis available mainly in the public domain, and that although they are most often used in pure sciences, technology and engineering, this form of protection can be more effective in the medical field. This is because it is common for senior professionals to develop surgical techniques for years and not to publish, for various reasons, however come another professional and publish, taking credit for having done the publication first. In addition, the author commented that the defensive publication, even if it is of hypotheses, ideas and opinions, allows the improvement of the original idea, but safeguarding intellectual property and protecting the rights of the original thinker.

The excess of activity with research, demands in laboratories and teaching often lead to a lack of time for the teacher/inventor to be involved in issues related to the production of technology, as it proves to be one of the requirements that shift the focus on patenting in universities (AGUILLERA, 2013).

By basing the authors who defend the publication, although incipient, with the defensive publication technique or observing that the main purpose of the researcher is the production of knowledge, one can lead to believe that:

Epb To achieve the best protection in innovation I can publish my research without concern for Intellectual Property, since I have a deadline to finish my research.

From the Innovation Law of 2016, which inserted prospecting actions and competitive intelligence by the Centers for Technological Innovation - NIT (CARVALHO and RENAULT, 2019), it began to play an essential role in technological development when prospecting and informational monitoring formed bases for competitive intelligence, boosting processes through information and knowledge management (CARVALHO et *al.*,2019) .

CARVALHO *et al.* (2019) highlighted that NIT builds several formal and informal information structures within the organization, as well as prospecting and monitoring activities that generate systematized informational services and products, with high added value.

The importance of some innovation centers was verified by Santos *et al.* (2020), among them: development of policies to innovation, management and increase in awareness of technological transfer and the use of intellectual property, sharing of human resources - intellectual capital - equipment and laboratories, generation of guidelines on the operation of business incubators. The authors highlighted bureaucratic and legal difficulties regarding the regulation of laws by their respective decrees, slow, incremental and long-term learning capacity of universities - private companies - public sector, and technological delay and innovative inefficiency beyond regional, national.

In the stated assumptions it would be possible to understand that:

EPcIn my innovation proposals I must seek the NIT for guidance and protection on Intellectual Property resulting from my research.

- Sources of knowledge to innovation (CF)

It is understood that innovation can be the result of various forms of knowledge, and authors such as Kör and Maden (2013) presented in their study the relationships between knowledge in the management and innovation process applied to organizations through a mediation of the effects of innovativeness. In the view of Apak and Atay (2014) the key component of a knowledge economy results from greater dependence on intellectual capacities on physical inputs or natural resources.

In view of these assertions, it is possible to infer that once social entrepreneurs represent the cell of a company and carry with them knowledge, and these, based on needs, present social innovations, according to Bhatti *et al.* (2018b), it is suggested that:

Fca. Practical knowledge of entrepreneurs and/or social inventors can contribute to the systematized innovation of academies.

Sternitzke (2010) argued that scientific knowledge from the public sector is considered important for all innovations.

Pedrosi Filho(2014) added that patenting and publishing are compatible and that the dissemination of the results of scientific research is fully compatible with the protection of the resulting inventions, through patents or any other form of industrial protection. However, he stressed that if the researcher believes that some invention derived from his investigations is new and has possibilities of commercial

exploitation, it should not be published. However, Mueller e Perucchi (2014) expressed the need for universities to be sources of knowledge applicable to the production of technologies.

It is understood that several studies of intellectual protection unders association with the relationship between the growth of knowledge measured by scientific publications and the technological growth measured by the index of publications of patent families (WIPO, 2019).

In view of the assumptions presented, the following are investigated:

FCb. All research should be published, since it can be a patent-producing source.

Aguillera (2013) perceived the University as a generating and disseminating element of knowledge, and innovation resulting from this passive scientific knowledge of protection, through intellectual property instruments, guaranteeing rights to the actors involved in terms of the proper appropriation of knowledge, besides enabling safe sharing and contributing to technological development.

Corsino; Mariani; Torrisi (2019) they stated that "external sources of knowledge by companies to develop patented inventions exploit the validity of patent citations as an indicator of knowledge flows between companies."

It was verified as structuring of technologies in Brazil, the support of the Brazil Bank Foundation, through its Social Technologies Bank (BTS), for including several publicly certified social innovations, in the form of articles of institutional dissemination, opening opportunities to know technological solutions capable of being reproduced free of charge with availability for incrementations (FUNDAÇÃO BANCO DO BRASIL, 2019).

According to the exposures verified, it would be possible to infer that:

FCc. Articles published by institutions can generate a source of knowledge to their innovation.

- Security Mechanisms (MS)

Several methods of valuation and technology transfer are used by the core of technological innovation, among them, there is the Theory of Real Options (TOR) (PAIVA; SHIKI, 2017), and the "TIRA" of the American acronym *Technology, Insertion, Recipient, Appreciation* (CARVALHO, T. V. *et al.*, 2017; DOMINGOS *et al.*,2018). With this, it is inferred that:

MSa. The researchers/inventors were/or should be responsible for evaluating the technology (e.g. TRL- Technology Maturity Level).

In the field of technology valuation and transfer, there is a recurrence of the theme in practical and theoretical discussions, since it involves several agents in the process of developing new technologies, in addition to researchers who do not accept interference, being refractory to responses from organs unrelated to their activities (ARAÚJO *et al.*,2017). With this, it is possible to consider that:

MSb. Researchers/inventors were/or should be responsible for the valuation of the technology.

It was verified in relation to the inventors that the various labor reasons, which lack the time for answering questionnaires about their activities and their laboratories in the valuation process (ARAÚJO *et al.*,2017), have proven to be one of the requirements that shift the focus away from patenting. However,

those who may submit refractories to the valuation method or patent application may feel more comfortable enumerating the clauses that permeate the relationship in technology transfer, and therefore:

MSc. Researchers/inventors were/or should be responsible for the production of technology contracts.

The researcher believing that the invention, based on his investigations, may present an innovative characteristic with possible commercial exploitation, should seek guidance from the body responsible for managing the intellectual property policy in his institution before any disclosure (FILHO, 2014).

Given the assertion that the researcher should be guided by the management body of the IP policy of the respective academic institution, it is inferred that:

MSd. The University is a relevant licensing mechanism for innovations.

- Hybrid attributes in innovation (AH)

The innovations present attributes that characterize aspects of an invention, bringing to light the possibility of perceptively attracting the investor or consumer market, among some of them: economics, accessibility, minimization of material resources, easy use or handling, robustness, quality, suitable for sales at scales or still sustainable (WEYRAUCH; HERSTATT, 2017).

Bas (2016) advocated a balance in the design of innovations based on frugality, which can both mean cost reduction, and operate in the context of resource restriction in which it operates.

The study that analyzed the cases of the U.S. and London rates of slower economic growth and the increase in costs for health spending due to the increasing prevalence of disease burden, they led Prime, Bhatti and Harris (2017) to suggest a convergence of these challenges faced by global health systems to economic accessibility as a metric relevant to the socially and economically disadvantaged, and stressed that both developed and emerging countries were becoming equally important for all, even if they enjoyed good social and economic conditions.

Uzoigwe e Shoab (2020) highlighted the cost reduction for the use of innovations with expired patents, and justified the effect of identical *designs* capable of radically impacting on the provision of services with greater accessibility. They exemplified the expiration of drug patents, with the subsequent use of generics that reached annual levels in million-dollar figures in the economy, concluding that "intellectual property [...] encompasses anodyne principles that seek to protect innovation, but are open to manipulation and exploitation".

Faced with aspects focused on cost reduction in order to favor the economies of societies and offer greater accessibility to markets, it is believed that researchers or inventors:

AHa. In research or patents I personally seek to analyze elements that can attribute a significant cost reduction to innovations when possible.

Among the various attributes that frugal innovation has to increase the chances of meeting market demands, production in scale or scalability draws the attention of authors such as Liu; Mr. Feng; Wang, (2020) in which this characteristic is used as a success factor and which is also supported by Agarwal et *al.* (2017a).

The demands for innovations in the world scenario, concomitant with the search for boosting in corporations, were observations of the authors Bhatti; Basu *et al.* (2018a) in which they presented frugal innovation as a set of activities for organizations to redesign products, services and reconfigure value chains, leading the cost item in the organization, increasing profitability and competitive advantage by achieving high performance at production scales – scalability – improving efficiency in general and reaching social needs.

In the series in which the global community has been identified with global health problems, and still insoluble in the face of new demands and challenges, Feng (2020) verified the urgent need to overcome these demands, supported by a more robust collaboration between international organizations, which can with a circular model and their thematic axes of innovation, research, digital health, basic care, economic sustainability and participation of communities and civil societies, to achieve possible ways to minimize the impacts caused (WORLD HEALTH ORGANIZATION, 2019).

In the area of Information and Communication Technology - ICT - it was found that the Internet of Things - IoT - offers many opportunities for pioneering new products and influence interconnected systems with immeasurable scalability, especially with the use of cloud computing resources (JASMINE; THEJAS, 2020. In the same segment, Rahmani and Li (2020) exemplified with their proposal to generate a scalable digital infrastructure to provide a sustainable energy network.

In this set of statements declared by the urgent need to meet a global scale in the various spheres, or even to suggest innovative models, it becomes noticeable that:

AHb. All innovation is a possible object of achieving a large scale for reproduction.

Reverse innovation is one of the concepts most associated with frugal innovation (BHATTI *et al.*,2018a) and as a case series, the invention of Arunachalam Muruganantham is observed under the creation of hygienic products with few resources, having knowledge formation for such invention from other inventions in the same segment (PRIYADARSHINI, 2018) . In Syed's statement; Dadwal and Martin (2013) "Reverse innovation in global health systems has the potential to contribute to the numerous health challenges faced by populations around the world."

Depasse e Lee (2013) recommended policymakers, entrepreneurs, health system leaders, and researchers to consider reverse innovation in accelerating the movement of promising solutions. This innovation was recently endorsed as a vehicle to promote bidirectional learning and the flow of information between low, middle and high income countries, with the aim of meeting common unmet needs (HARRIS; DADWAL; SYED, 2020).

Given the assumptions verified, it can be understood that once reverse innovation accelerates the innovation process, the time and cost in innovative solutions are reduced. So:

AHc. Using reverse innovation techniques will save time, resources and lead to even better innovation.

- Technology Transfer (TT)

The technological transfer was presented as an object of academic and corporate interest in the publication of Sagafi-Nejad and Belfield (1941) in which they cited the role of the United Nations, supported by international agencies and agencies, in this international process.

Mueller e Perucchi (2014) expressed the need for universities to be sources of knowledge applicable to the production of technologies. Domingos *et al.* (2018) ratified this assumption, exploring the concept of Technology Transfer (TT) as a disseminator for science and technology produced in the academic environment to the productive environment, [...] ranging from the pure transfer of knowledge to the transfer of information, processes, functions, implementations, or even, enabling the promotion of the creation of new companies.

Thus, the numerous contributions based on the university-company relationship in favor of society by innovations, allows the observation of variables that arise in this relationship of technological transfer, such as: *sustainability, care for the environment, production on a global scale, negotiation mechanisms in technology transfer, information systems of logistic support, methods of technological valuation and the quality of these innovations.*.

Sustainability

Organizations and social enterprises that have adopted frugal innovation strategies have achieved high-quality results in products and services, applicable and accessible to emerging markets, with a view to global sustainability due to the use of critical requirements or success factors. From his examples, we observed requirements such as: robustness; lightness of good (portable); *IoT* solutions with mobile connectivity; easy-to-use or intuitive projects; simplified or minimalist to meet functional requirements; available in unconventional channels; adaptable to existing products or services; usable with local resources, no need to import equipment or materials; powered by renewable *resources* (green technologies); affordability (BASU; BANERJEE; SWEENY, 2013).

In medicine, the gaps that made innovations scalable could be achieved by technological implementations to mobile devices and sensors, which meant a great potential for global health, through the defense of cheap and effective solutions to common problems in diagnostics, medical procedures and access to information, benefiting environments with or without resources (LUNDIN; DUMONT, 2017).

With regard to aspects of sustainability and scarcity of resources, it was found in Hossain (2018), that frugal innovation is appreciable as a means of providing economic and social benefits, preserving natural resources, such as materials, energy and water. In view of this, one can contribute to the awareness that:

TTa. Sustainability requirements should be mandatory items for technology transfer innovations as natural resources are becoming scarcer.

Through studies that presented paradoxes of sustainability to the environment, it was evaluated how solutions could be had to transfer, with greater safety, technologies that impact the environment, such as energies that produce radioactive or toxic waste and that are not yet being possible to reuse them fully (GUIMARÃES, 2016; KHELURKAR; SHAH; JESWANI, 2015; SOVACOOL, 2012).

Thus, based on patent studies, we examined the evolution of innovation in nuclear energy reactors in the period between 1974 and 2008 in twelve OECD countries, and evaluated the extent to which nuclear innovation has been driven by economic incentives, political decisions and considerations on safety regulations. It was found that after the nuclear accidents of *Three Miles Island* and *Chernobyl*, there were indexes with a negative impact on nuclear innovation (BERTHÉLEMY, 2012).

On the other hand, the work of Halevi *et al was verified.* (2020) in which it was possible to make an invention for selective removal of radioactive cationic species, decontaminating nuclear waste water with environmental cleanliness after accidents, as happened in the Fukushima Daiichi Nuclear Power Plant disaster in 2011, in which through three-dimensional (3D) digital light processing (DLP) printing, monoliths were formed from ionic post-exchange of zeolites, which are known to be good for the treatment of nuclear effluents or in applications and processes based on aqueous separation.

Analyzing results of unfavorable impacts from nuclear or positive accidents regarding radioactive waste remediating technologies, it is possible to understand that:

TTb. There must be technology transfer with innovations that degrade the environment.

Bureaucracy is among the various barriers to innovation and technological transfer (FABRIS, 2016; RUSSO, FABRIS and SILVA-MAN, 2019). This is an undoubted and essential variable for the formalization of proceedings between formal institutions that respond to the laws of the parties involved, or when these parties owe an obligation to the legal order of their territoriality, or when extraterritoriality uses the international treaties and agreements that permeate the intersection of interests (IRINEU et *al.*, 2019).

It is possible that *Smartcontracts* can contribute to the efficiency and acceleration of agreements as a way to assist in the dynamics of negotiations, speeding up approximations to convergent points and driving away divergences in the interests of the parties (MATTEREUM, 2020), as well as adapting fluidly, according to the dynamic conditions of new situations (RAHMANI; LI, 2020).

By observing the references about frugal innovations, it is possible to achieve technological solutions prone to scalability (AGARWAL *et al.*,2017b; AHUJA and CHAN, 2016), considering *startups* (CARVALHO *et al.*,2017) is that,

TTc Transfer Contracts must present broad flexibility so that innovations can be prepared for productions on global scales.

Technological valuation

Paranhos, Cataldo e Pinto (2018) demonstrated the case of industrial, technological and foreign trade policy (PITCE), in which a Science and Technology (S&T) policy was established in the Science and Technology Growth Acceleration Program (S&T PAC) and the first incentive of the program was the training and training of human resources for the AREA of CT&I, demonstrating the relevance of people qualified in stimulating the partnership between Institutes of Science and Technology - ICT and companies through the "Capes National Postdoctoral Program".

Tavares, Philippi and Porto (2019) highlighted the role of agents who are trained to deal with the process and bureaucracy in licensing activities, in which there is a need for dynamism, both in its development and in its execution, aiming to minimize the response time and adjustments to meet the demand for commercialization of technology, observing the need for professionals who understand the subject to accelerate the flow of processes.

Depending on the assertions and among the various forms of technological valuation to reach the stage of transfer of intellectual assets (LEITE *et al.* 2019), the requirement of expanded knowledge by intellectual property professionals is unique, when observing the diversity of variables that involves the evaluation of innovations. And therefore, it is *sine qua non* to crave that the

TTd Valuation of innovation for transfer can be carried out through professionals who are accredited by academic NIT.

o Methodology

The research developed by the *survey* method had the perception of 84 researchers-inventors, limited to capes research groups, in the areas of engineering, with an instrument validated by 5 doctors who know the intellectual property.

The sample was endowed with Westland's computational algorithm (2010) in the resources of the *G*Power* tool, which were based on Fisher's fundamental studies (1936). With the quantitative analysis of the sample, a qualitative analysis was previously performed, extracting those patents that had an inventor-company-government relationship with and without internationalization.

The query used Google's electronic forms tool®, with unique *email* account identified by *frugalsurvey@gmail.com.* Data collection was performed between the periods of 08/30/2019 and 03/28/2020, requesting answers to 307 contacts, returning, 84.

The measurement of the perception of the group of respondents (table 9) occurred with a gradual scale of intensity represented by 5 points, ranging from 1 to 5, being: {1 = I disagree totally; 2 = I disagree partially; 3 = Neither agree nor disagree; 4 = I partially agree; 5 = I agree totally} (LIKERT, 1932; YOUSSEF; HAAK-SAHEEM; YOUSSEF, 2017).

Table 1. Likert's proposal and scale adopted to the questionnaire

1	2	3	4	5
I disagree totally	**I disagree partially**	**Neither agree, nor disagree**	**I partially agree**	**I agree totally**

Source: Authors.

The instrument had open questions regarding the profile of the sample, invoking names or acronyms of graduate programs, affiliation, time of performance with patents, number of patents with technological transfer and number of patents that presented *royalties.*

The basis of the assumptions, with their respective evidence, was based bibliographically through scientific articles, peer-reviewed, however, certain references were obtained by *webpages* consulted by the Google and Google Scholar mechanism.

Pearson's correlation method (KOTHARI, 2010) was applied to analyze the relationship between technological production and technology transfer.

$$\rho = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(yi - y)}{\sqrt{\sum_{i=}^{n} 1\,(x_i - \bar{x})^2}.\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}} = \frac{\mathrm{cov}(x, y)}{\mathrm{var}(x) \cdot \mathrm{var}\ (y)}$$

$x_1, x_2,...,x_n$ and $y_1, y_2,...,y_n$ are the measured values of both variables. And

therefore, $\bar{x} = \frac{1}{n} \cdot \sum_{i=1}^{n} x_i$ and $\bar{y} = \frac{1}{n} \cdot \sum_{i=1}^{n} y_i$ are the arithmetic means of both variables.

As for the parameters of interpretation of the *Pearson*index, one has: 0.9 for more or less, indicates a very strong correlation; 0.7 to 0.9 positive or negative, indicates a strong correlation; 0.5 to 0.7 positive or negative, indicates a moderate correlation; 0.3 to 0.5 positive or negative, indicates a weak correlation; 0 to 0.3 positive or negative, indicates a negligible correlation (KOTHARI, 2010).

To discuss the results according to the hypotheses announced in theoretical reference, the following items are analyzed: Protection Elements, Knowledge Sources, Security Mechanism, Hybrid Attributes, Technology Transfer (Table 11).

Table 2. Set of hypotheses investigated

Block No.	Construct	Number of items
1	Protective Elements (EP)	3
2	Sources of Knowledge (FC)	3
3	Security Mechanism (MS)	4
4	Hybrid Attributes (AH)	3
5	Technology Transfer (TT)	4
Total		17

Source: Authors.

The research is the result of a database developed and ceded for the analysis of the relationships of Connections between Companies and University (FABRIS, 2016).

Results

The following will be possible to understand the results from the sub-items: Analysis of the sample, results and results of the hypotheses.

Sample analysis

Verifying the general data achieved and available in Appendix D, it was able to highlight and consolidate the results, by plotting an analysis in 4 levels: professional, geographic, institutional and technological, respectively in the sub-items 6.4.2 to 6.4.4.

Professional level

It was found at the level of training that there is a greater participation of the group belonging to the postdoctoral level, with, 55 participants, corresponding to 65.48% of the sample; doctorate (25; 29.76%); Master's degree (3; 3.57%); specialization (1; 1.9%). In the aspect that highlights the time of performance in the production of patents, in years, it was found that 3 respondents represent less than 1 year in operation. As for the professional with the highest expertise, in working time, there is 1 respondent with 55 years, with the modal value of 7 respondents equal to 20 years of experience, and the average time in working time, 22.38 years.

The main areas of activity of researchers in the North are concentrated in the areas of health, such as: Biomedicine, Dentistry, in at least 5 graduate programs. In the Northeast, the areas of Oil and Gas, Civil and Materials Physics in Sergipe stand out, and in other universities, there are researchers in the areas of Biochemistry, Chemistry, Biotechnology, Biomedicine, Mechanics, Pharmaceutical Nanotechnology, Materials, Biomaterials, Biotechnology, Metallurgical, Electrical. In the Midwest, they are: Biomedicine, Electrical, Pharmacy, Agronomic and Chemistry. In the Southeast, the researchers work strongly in the Rio-São Paulo axis with Chemistry, Naval and Oceanic, Physics, Electrical, Computing, Cell and Molecular Biology, Biomedicine, while in Espírito Santo are focused on the areas of the earth, such as Agrarian, Agronomy, Biology, Ecology, and in Minas Gerais, the Chemical, Biomedicine, Speech Therapy, Sanitary, Materials and Metallurgical, Food and Nanobiosystems areas. For the South region, the chemical, mechatronics and geomatics, electrical, materials, metallurgical, mechanical and aerospace areas stand out.

Geographical level

In a total of 37 institutions, the North region had the participation of 2 universities and 5 respondents, Midwest (3;8), Northeast (11;18), Southeast (16;39), South (6;14).

The mean and modal index of professionals regarding the level of education in all states are 4.42 and 4 per state, respectively. Above this average, the highest concentration of inventors at the level of training, post-doctors (PD), doctors (D), masters (M) follow the count: Paraná (3PD, 2D), Santa Catarina (3PD, 2D, 1M), São Paulo (7PD), Minas Gerais (9PD, 2D, 1M) and Rio de Janeiro (11PD, 5D).

Among the 78 graduate programs (PPG) that resulted in technological productions, The following indexes were presented respectively in number of programs and patent count (P) in the regions: North (6PPG; 8P), Midwest (8PPG;72P), Northeast (25PPG;82P), Southeast (28PPG;283P), South (11PPG;175P).

Institutional level

Of the 37 institutions analyzed that are part of the sample, it was verified the participation, in particular, for the Northern region of the Federal University of Pará with 7 patents (P), and it was not

possible to find patents at their time transferred (T) or with participation in *royalties* (R). For the Northeast, the Federal University of Sergipe (30P;0T;0R) stood out, however, the Federal University of Rio Grande do Norte, despite having a smaller number of patents in its count, presented a higher number of patents transferred and with royalties (5P, 2T, 17R). In the Midwest, the University of Brasília stands out (40P;10T;3R). In the Southeast region, the Federal University of Rio de Janeiro (89P;36T;2R) and UFSCAR (61P, 10T, 3R) stand out. In the Southern region, the Federal Technological University of Paraná with (63P, 56T, 0R), followed by the Federal University of Santa Catarina (36P, 4T,1R) and the Federal University of Rio Grande do Sul (26P, 1T, 2R) stand out.

Technical level

In the technological aspect of the institutes, it was found that among the amount of 620 patents produced, 158 reached the process of technological transfer, and effectively 35 patents, of this total quantity, reached the return of investments through *royalties.* In data on the total sample, patents with technological transfer resulted in approximately 20.31%, and patents with royalties presented about 5.34%. Thus, it is demonstrated that the productive chains can take advantage of up to 94.66% of the total knowledge potential produced in universities (Table 12).

Table 3. Technological indices by Institutos

Institute by Region	**PATENTS in PPG**	**Patents with Transf. Technology**	**Patent Royalties**
Midwest	**72**	**15**	**4**
UFG	12	2	1
UFMS	20	3	0
UNB	40	10	3
Northeast	**82**	**4**	**19**
IFBA	2	0	0
IFCE	3	0	1
IFPI	1	0	0
UFAL	1	0	0
UFBA	1	0	0
UFC	13	0	0
UFPE	22	2	1
UFPI	4	0	0
UFRN	5	2	17
UFS	30	0	0
North	**8**	**0**	**0**
UFAM	1	0	0
UFPA	7	0	0
Southeast	**283**	**74**	**7**
IFRJ	1	1	0
IME	13	0	0
INMA	1	0	0
PUC	14	3	2

UFES	1	2	0
UFF	2	1	0
UFMG	59	5	0
UFRJ	89	36	2
UFRRJ	4	0	0
UFSCAR	61	10	3
UFV	2	0	0
UNICAMP	34	16	0
UNIFAL	2	0	0
South	**175**	**65**	**5**
IFC	0	3	2
UDESC	6	1	0
UFPR	44	0	0
UFRGS	26	1	2
UFSC	36	4	1
UTFPR	63	56	0
National Average	**7,56**	**1,88**	**0,42**
National Total	**620**	**158**	**35**

Source: Authors.

By nationally correlating the production of patents in graduate programs (PPG) with the total number of patents that achieved technological transfer (TT), by region, by *pearson*method, the moderate correlation index R=0.65 could be found (Table 13). However, when evaluating the correlations by region with analyses of the universities individually, it is obtained that in the Midwest the correlation is very strong, reaching R=0.99 approximately; Northeast (0.27) negligible; Southeast (0.85) strong; South (0.69), moderate.

Table 4. PPG correlation and sum of patents by region

Region	**Quant PPPG**	**Quant Patents**	**Correlation**
North	8	0	-
Midwest	72	15	0,986241383
Northeast	82	4	0,271541396
Southeast	283	74	0,845094036
South	175	65	0,688035628
National			0,938654297

Source: Authors

Results of the hypotheses investigated

The metrics that sized researchers' perceptions about innovation and intellectual property in the process of technological transfer show that for the hypothesis classes: Disagree Totally (DT), Disagree Partially (DP), Do not Agree or Disagree (N), Partially Agree (PA), Totally Agree (TA), they are highlighted:

Elements of Protection to Innovations

EPa. Every researcher or inventor generating innovations must know about the protection mechanisms (TA 65.48%; PA 29.76%) (OPPENHEIM, 2020; BRAZIL, 1998; BRAZIL, 1996). EPb. To achieve the best protection in innovation I can publish my research without concern for Intellectual Property, since I have a deadline to finish my research (DT 50%; SD 19.05%) (HENKEL; PANGERL, 2008; SHYAM 2014; ARAÚJO *et al.*,2017) . EPc. In my innovation proposals I must seek the NIT for guidance and protection on Intellectual Property resulting from my research (TA 67.86%, PA 25%) (OAK; RENAULT, 2019 ; CARVALHO *et al.*, 2019 ; SANTOS *et al.*,2020) .

Sources of Knowledge

FCa. Practical knowledge of entrepreneurs and/or social inventors can contribute to the systematized innovation of academies (TA 55.95%; PA 41.67%) (KÖR; MADEN, 2013; APAK; ATAY, 2014; BHATTI *et al.*,2018b). FCb. All research should be published, since it can be a patent-producing source (PA 41.67%, TA 32.64%) (STERNITZKE, 2010; PEDROSI FILHO, 2014; MUELLER; PERUCCHI, 2014; WIPO, 2019). FCc Articles published from institutions can generate a source of knowledge to their innovation (TA 79.76%; PA 15.48%) (AGUILLERA, 2013; CORSINO, MARIANI; TORRISI, 2019; BANCO DO BRASIL FOUNDATION, 2019).

Security Mechanisms

MSa. The researchers/inventors were/or should be responsible for the evaluation of the technology (PA 41.67%; TA 19.05%) (PAIVA; SHIKI, 2017 ; CARVALHO *et al.*,2017; DOMINGOS *et al.*,2018). MSb. Researchers/inventors were/or should be responsible for the valuation of the technology (PA 36.90%; SD 20.24%) (ARAÚJO *et al.*,2017) . MSc. Researchers/inventors were/or should be responsible for the production of technology contracts (DT 28.57%; SD 25%) (ARAÚJO *et al.*,2017) . MSd. The University is a relevant mechanism for licensing innovations (TA 53.57%; PA 30.95%) (PEDROSI FILHO, 2014) .

Hybrid Attributes in Innovation

Aha. In research or patents I personally seek to analyze elements that can attribute a significant cost reduction to innovations when possible (TA 59.52%; PA 30.95%) (WEYRAUCH; HERSTATT, 2017 ; BAS, 2016 ; PRIME, BHATTI; HARRIS, 2017 ; UZOIGWE; SHOAB, 2020). . AHb. All innovation is a possible object of achieving a large scale for reproduction (PA 45.24%, SD 19.05%) (LIU; Mr. FENG? WANG, 2020 ; AGARWAL et al., 2017a ; BHATTI et al., 2018a ; FENG, 2020 ; WORLD HEALTH ORGANIZATION, 2019 ; Jasmine; THEJAS, 2020; Rahmani; LI, 2020). Ahc. Using reverse innovation techniques will save you time, resources and lead to even better innovation (PA 45.24%; TA 32.14%) (BHATTI; BASU et al., 2018a), (PRIYADARSHINI, 2018), Syed, Dadwal and Martin (2013) and Depasse and Lee (2013) , (HARRIS; DADWAL, SYED, 2020.

Technology Transfer

Tta. Sustainability requirements should be mandatory items for technology transfer innovations as natural resources are becoming scarcer (TA 44.05%; PA 41.67%) (BASU; BANERJEE; SWEENY, 2013; LUNDIN, D-200 DUMONT, 2017 ; HOSSAIN, 2018) . TTb. There should be technology transfer with innovations that degrade the environment (PA 33.33%; SD 21.43%) (GUIMARÃES, 2016; KHELURKAR; SHAH; JESWANI, 2015; SOVACOOL, 2012; BERTHÉLEMY, 2012; HALEVI *et al.*,2020). TTc. Transfer contracts must have broad flexibility so that innovations can be prepared for production at global scales (TA 42.86%; PA 33.33%), (FABRIS, 2016; RUSSO, FABRIS, SILVA-MAN, 2019 ; IRINEU *et al.*,2019 ; MATTEREUM, 2020 ; Rahmani; LI, 2020 ; AGARWAL *et al.*,2017b; AHUJA, AHUJA, AHUJA; CHAN, 2016 ; CARVALHO *et al.*,2017) . (TTd) Valuation of innovation for transfer can be performed through professionals who are accredited by academic NIT (PA 41.67%; TA 35.71%) PARANHOS, CATALDO AND PINTO (2018); TAVARES, PHILIPPI AND PORTO (2019); (LEITE ET AL.; 2019).

In table 14, depending on the approaches performed with their respective main indexes, one can observe in visual detail, their utterances with all the ranges of options of the Likert scale.

Table 5. Constructs and Likert scales

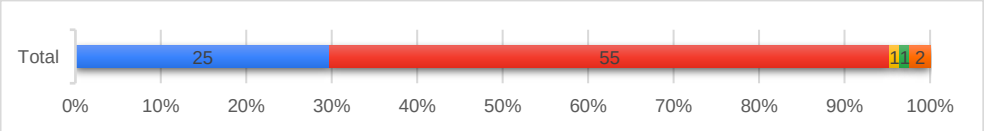
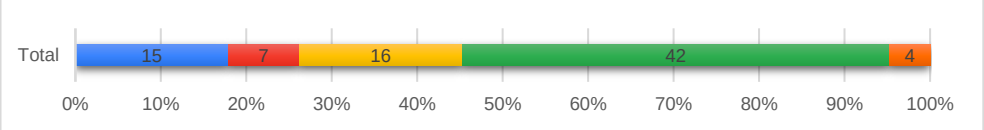
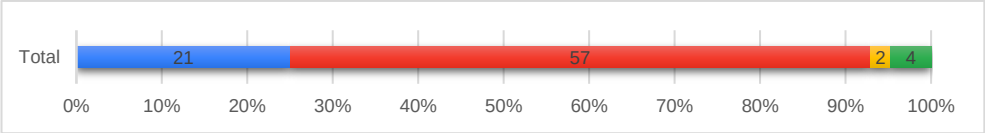
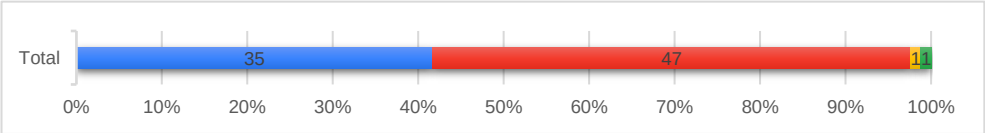
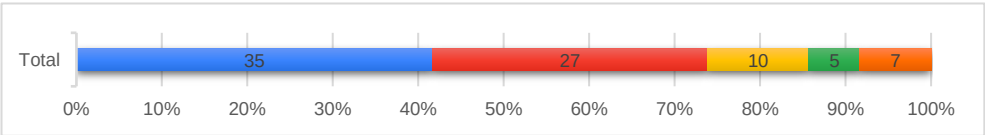
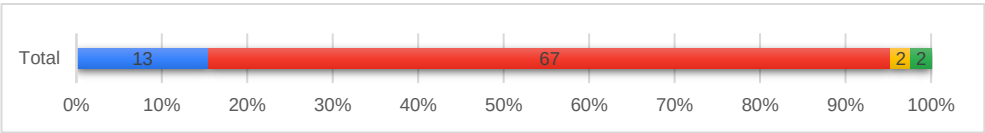
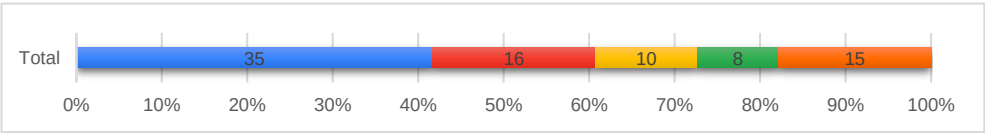
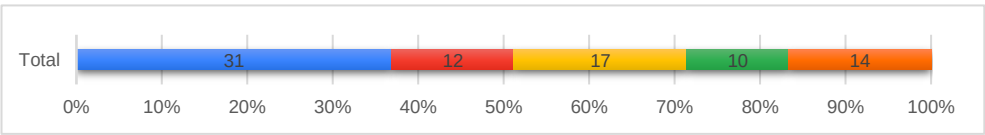
Constructs	Observable Variables / Description / Reference / Likert Scale / Status	
Protection Elements	**EPa**	Every researcher or inventor generating innovations must know about the mechanisms of protection Oppenheim (2020), (BRASIL, 1998), (BRASIL, 1996).
		
	EPb	To achieve the best protection of my innovation I can publish my research without concern for Intellectual Property once I have a deadline to finish my research (HENKEL; PANGERL, 2008). Shyam (2014) (ARAÚJO *et al.*, 2017)
		
	EPc	In my proposals for innovations, I must seek the NIT for guidance and protection on Intellectual Property resulting from my research (CARVALHO e RENAULT, 2019), (CARVALHO *et al.*, 2019),(SANTOS *et al.*, 2020)

Table 5. Constructs and Likert scales

Constructs	Observable Variables / Description / Reference / Likert Scale / Status	
		
Knowledge sources	**FCa**	Practical knowledge of entrepreneurs and / or social inventors can contribute to the systematized innovation of academies. *Kör e Maden (2013); Apak e Atay (2014);* (BHATTI *et al.*, 2018b)
		
	FCb	All research must be published, since it can be a source of patents *Sternitzke (2010), Filho (2014), Mueller e Perucchi (2014),* (WIPO, 2019)
		
	FCc	Published articles from institutions can generate a source of knowledge to your innovation *Aguillera (2013),Corsino; Mariani; Torrisi (2019),* (FUNDAÇÃO BANCO DO BRASIL, 2019).
		
Security Mechanism	**MSa**	Researchers/inventors were/should be responsible for the evaluation (e.g. TRL-Technology Maturity Level)? (PAIVA; SHIKI, 2017), (CARVALHO, T. V. *et al.*, 2017; DOMINGOS *et al.*, 2018).
		
	MSb	Researchers/inventors were/should be responsible for valuing the technology (ARAÚJO *et al.*, 2017).
		

Continue...

Table 5. Constructs and Likert scales

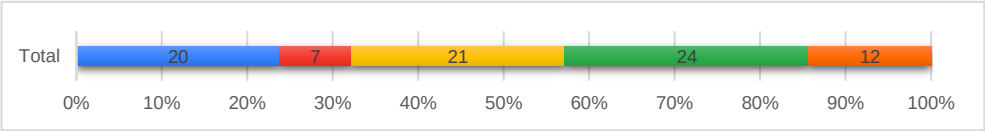
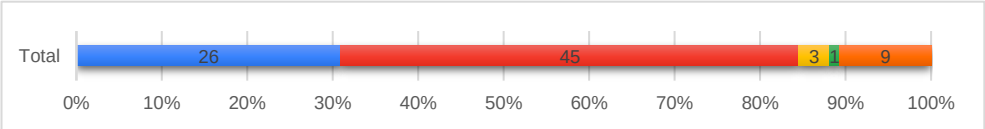
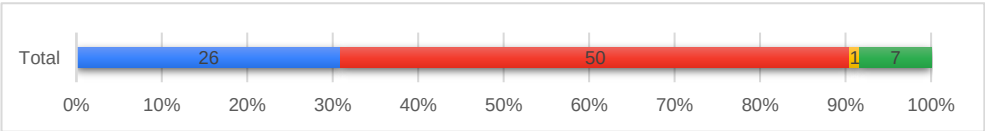
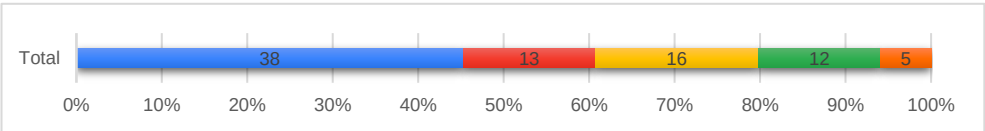
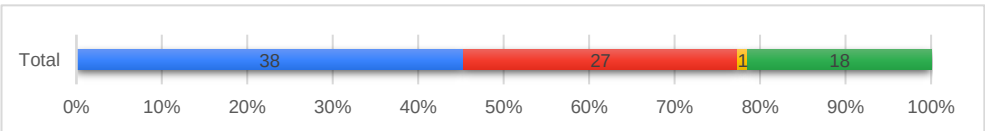
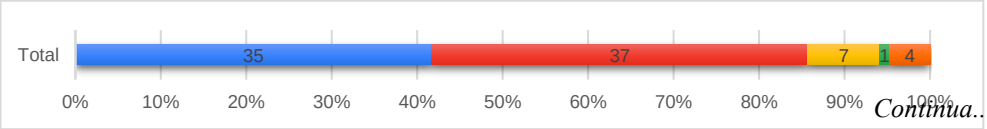
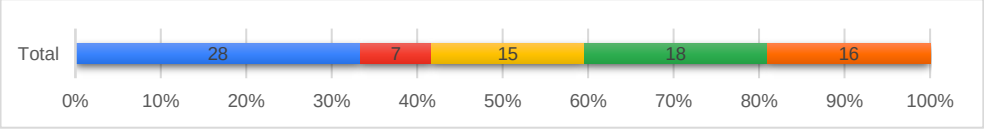
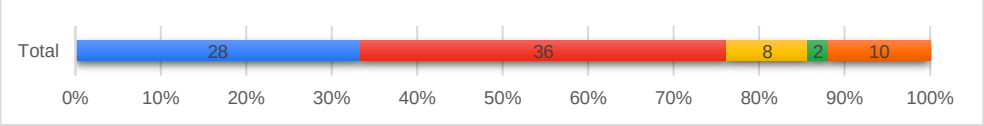
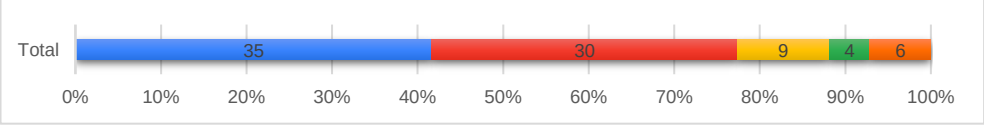
Constructs	Observable Variables / Description / Reference / Likert Scale / Status	
	MSc	Researchers/inventors were/should be responsible for producing the technology contracts (ARAÚJO *et al.*, 2017)
		
	MSd	The University is a relevant licensing mechanism for innovations *(FILHO, 2014)*
		
Atributos Híbridos	**AHa**	In research or patents I personally seek to analyze elements that may attribute a significant cost reduction to innovations when possible (WEYRAUCH e HERSTATT, 2017), Bas (2016), Prime, Bhatti e Harris (2017) Uzoigwe e Shoab (2020) *Continue...*
		
	AHb	Every innovation is possible to achieve a large scale for reproduction (LIU; FENG; WANG, 2020), (AGARWAL *et al.*, 2017a), (BHATTI *et al.*, 2018a), *Feng (2020)*, (WORLD HEALTH ORGANIZATION, 2019), *(JASMINE; THEJAS, 2020), Rahmani e Li (2020)*
		
	AHc	Using reverse innovation techniques will save you time, resources and can lead to even better innovation *(BHATTI; BASU et al., 2018a), (PRIYADARSHINI, 2018), Syed, Dadwal e Martin (2013) e Depasse e Lee (2013), (HARRIS; DADWAL; SYED, 2020)*
		

Table 5. Constructs and Likert scales

Constructs	Observable Variables / Description / Reference / Likert Scale / Status	
Technology Transfer	**TTa**	Sustainability requirements should be mandatory items for innovations for technology transfer as natural resources are becoming scarcer *(BASU; BANERJEE; SWEENY, 2013,* (LUNDIN; DUMONT, 2017), (HOSSAIN, 2018)
		 *Continua...*
	TTb	There must be technology transfer with innovations that degrade the environment (GUIMARÃES, 2016; KHELURKAR; SHAH; JESWANI, 2015; SOVACOOL, 2012), *(BERTHÉLEMY, 2012), HALEVI et al. (2020)*
		 *Continue...*
	TTc	Transfer contracts must be flexible enough so that innovations can be prepared for production on a global scale *(FABRIS, 2016; RUSSO, FABRIS e SILVA-MAN, 2019).* (IRINEU *et al.*, 2019), (MATTEREUM, 2020), (RAHMANI; LI, 2020), *(AGARWAL et al., 2017b; AHUJA e CHAN, 2016), (CARVALHO et al., 2017)*
		
	TTd	Do you understand that all valuation of my innovation for transfer can be done through professionals who are accredited by the NIT of the academies? PARANHOS, CATALDO E PINTO (2018); TAVARES, PHILIPPI E PORTO (2019); (LEITE *ET AL.*; 2019)
		

Legend: I partially agree I totally agree Neither agree, nor disagree I partially disagree I disagree totally

1.1.Conclusion

The research revealed an important contribution of researchers with their perceptions about the themes related to Intellectual Property, Innovation and Technological Transfer, within the sets of hypotheses analyzed and willing to follow:

In the aspect of the protection of innovations, every researcher or inventor generating innovations should know about the protection mechanisms and that the proposals for innovations should seek the NIT for guidance and protection on intellectual property.

As for sources *of knowledge* inspiring innovation, the practical knowledge of entrepreneurs and/or social inventors can contribute to the systematized innovation of academies, just as all research should be published, since it can be a patent-producing source. As for articles published by institutions, they can generate a source of knowledge inspiring innovation.

With regard to *innovation security mechanisms,* researchers/inventors should partly be responsible for the evaluation and valuation of the technology produced and that the University is a relevant licensing mechanism for innovations.

Hybrid Attributes in Innovation should be observed regarding the significant cost reduction to future innovations, as well as scalability should be objectively sought when possible.

In *Technology Transfer*, requirements such as sustainability should be mandatory items for technology transfer innovations, since natural resources are becoming scarcer, and that instruments of agreements, such as transfer contracts, should present broad flexibility so that innovations can be prepared for productions on global scales. The valuation of innovations is relevant when performed through professionals who are accredited by the NIT of the academies

In global efforts among researchers, universities and companies, only about 5% of patents have reached the level of *royalty* generation, demonstrating that the other 95% are still available for potential exploitation for society. It was found that by nationally correlating the production of patents to graduate programs (PPG) with the total number of patents that achieved technological transfer (TT), by region with analyses of universities individually, it is obtained that in the Midwest the correlation is very strong, reaching R=0.99 approximately, Northeast (0.27) negligible, Southeast (0.85) strong, South (0.69), moderate. And at the national level evaluated by regional indices, the correlation index R=0,94, very 94 strong, is presented.

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