LUMEN ET VIRTUS
ISSN: 2177-2789

AN INTRODUCTORY REVIEW ON CHALLENGES AND STRATEGIES FOR TECHNOLOGY TRANSFER IN PUBLIC ICTS: A STUDY ON INTELLECTUAL PROPERTY AND INNOVATION ECOSYSTEMS IN BRAZIL

https://doi.org/10.56238/levv16n47-024

Submitted on: 10/03/2025 **Publication date:** 10/04/2025

Humberto Henrique Brotto Ramos[1], Raphael Magalhães Gomes Moreira[2], Larissa Haddad Souza Vieira[3], Sávio da Silva Berilli[4], Laila Caetano Bonjardim[5], Julio Cesar Nardi[6], Ariana Oliveira Gusmão[7],Lorhana Ferreira Silva[8].

ABSTRACT

This work focuses on aspects related to Intellectual Property (IP), Technology Transfer (TT) and innovation, taking into account the context of the Federal Institute of Espírito Santo (Ifes), with Agifes as a case study. Through a literature review, the difficulties faced by Science and Technology Institutions (ICTs) and Technological Innovation Centers (NITs) in Brazil are discussed, with emphasis on the Helix models – Triple, Quadruple and Quintuple – which bring together universities, government, the productive sector and society in an ecosystem of innovations. The analysis covers the evolution of innovation policies in Brazil, with an emphasis on the continuous training of people working in this area and the best technology transfer strategies, exemplified by reference ICTs, such as USP, Unicamp and Embrapa. In addition, an analysis of strategic communication is made, focusing on Endomarketing actions, the adherence and engagement of researchers, and the alignment of scientific innovations with market demands. It is concluded that the combination of applied research, protection of knowledge property and partnerships with the productive sector are the key factors that transform scientific knowledge into economic and social impact, corroborating the importance of IP and TT management in ICTs.

[1] Master's student at ProfNit at Polo Ifes campus Colatina
E-mail: humbertobrotto@ifes.edu.br
[2] Permanent D.Sc. Professor of ProfNit at Polo Ifes campus Colatina and of the Master's Degree in Coffee Growing at Ifes campus Itapina
Email: raphael.moreira@ifes.edu.br
[3] Permanent D.Sc. Professor of the Master's Degree in Coffee Growing at Ifes campus Itapina
Email: larissa.vieira@ifes.edu.br
[4] Permanent D.Sc. Professor of ProfNit of the Ifes campus Colatina of the Master's Degree in Coffee Growing of the Ifes Itapina campus and of the Master's Degree in Agroecology of the Ifes campus of Alegre
E-mail: savio.berilli@ifes.edu.br
[5] Master's student at ProfNit at Polo Ifes campus Colatina
E-mail: laila.bonjardim@ifes.edu.br
[6] Permanent D.Sc. Professor of ProfNit of the Ifes campus Colatina
Email: julionardi@ifes.edu.br
[7] Master in Sustainable Technologies
E-mail: arianaolig@gmail.com
[8] Master's student at ProfNit at Polo Ifes campus Colatina
E-mail: loraafs@gmail.com

Keywords: Technological Innovation Centers. Public policies for ST&I. Commercialization of technologies. Professional training.

INTRODUCTION

IP and technology transfer (TT), added to other actions, such as the promotion of Research, Development and Innovation (RD&I), entrepreneurial culture and good practices in knowledge management, bring together essential actions for the success of an NIT and ICTs. Therefore, they are important tools to contribute to the leverage of institutional innovation and, consequently, in the results for the so-called "local innovation ecosystem[9]".

In the context of Ifes, its Innovation Agency[10] (Agifes) fulfills the function of NIT, which aims to stimulate, manage and support activities focused on intellectual property (IP), technological entrepreneurship and innovation. To this end, it develops activities related to three areas of activity: IP, Enterprise Incubator and Technological Service.

IP comprises creations of the mind such as inventions, literary and artistic works, symbols and *designs*, names and images, involving the legal rights granted over these intellectual creations, including patentable inventions, trademarks, industrial designs, copyrights and cultivars, ensuring the protection and encouragement of innovation. These are rights that allow people to gain recognition or financial benefit from inventions, desiring a balance between the interests of innovators and the broader public interest. And it is then in the context of ICTs, IP enables the valorization and commercialization of scientific knowledge, promoting interaction between universities and the productive sector (WIPO, 2020; BRASIL, 1996).

Technological Services are specialized activities provided by ICTs and their laboratories, aimed at carrying out tests, technical analyses, certifications and consultancies for companies and institutions. These services allow the practical application of scientific knowledge in industry and in the productive sector, stimulating innovation and increasing competitiveness, according to the guidelines of the Legal Framework for Science, Technology and Innovation (BRASIL, 2016) and the Organization for Economic Cooperation and Development (OECD, 2015).

In their multitasking, NITs should work in the synergy of several work fronts, in order to associate IP and TT with actions that promote RD&I and the entrepreneurial culture, because according to Perkmann *et al.* (2013), it is efforts of this nature that ensure the participation of students, and consequently, guarantee social legitimacy for the research. It is good to say that Pietrovski *et al*. (2020) present good excerpts in research carried out by

[9]An environment and what is part of it in statewide scope, whose pillars also involve actors such as universities, companies, governments, investors, entrepreneurs and other interconnected organizations.
[10]Nucleus or structure of Ifes with the action involving the stimulation of the protection of intellectual property, the interaction between Ifes and the productive sector, and the promotion of applied research and the development of technological solutions that meet the demands of society and the market, operating in accordance with the Innovation Law (Law No. 10.973/2004) and the institutional policies of Ifes.

interviews, questionnaires and secondary data obtained by documents, for which it is worth pointing out topics and reference authors such as Coelho and Dias (2016), Hewitt-Dundas (2012) and Santos Silva *et al* (2015), dedicated to guiding the internal community of the Higher Education Institution (HEI) on IP and reinforcing that there is a regulation providing for the ownership and participation in the results of the exploration of intellectual creations developed in these institutions.

This work addresses the themes of IP, to equip those who are interested in the development of varied activities with the valorization of various aspects of registerable intellectual knowledge or knowledge strategically guarded "in secret". It is intended to collaborate with the reader in the preparation and proposition of institutional documents that promote understanding and engagement in industrial property and TT issues.

BACKGROUND

So that the relationship and the interaction between the Institute and the Company can actually happen in significant proportions, so that the inventions are beyond the patents that are not being marketed or produced, the so-called "inventions or shelf patents", and consequently the results of IP and TT protection can in fact happen in proportions that demonstrate real institutional evolution in innovation, it is imperative that the Agency acts on the communication on the subject, boosting the culture of innovation in its field of action.

Even after good efforts and creative approaches to direct actions and guide researchers, Agifes, in turn, can put itself in the right to assess that each of the recipients of the communications also needs to intensify the relationship with the NIT. One of the main obstacles is the lack of knowledge about the mechanisms of IP and TT among Ifes researchers. Many are unaware of the advantages of protecting their inventions or the best practices to transfer them to the productive sector. This gap compromises the valuation of the technologies generated and can result in the loss of innovation opportunities. In this context, the implementation of effective communication strategies is crucial to sensitize researchers about the importance of protecting and disseminating their creations.

Internal marketing emerges as a strategic tool to broaden researchers' understanding of IP and TT, promoting a culture of innovation within Ifes. The adoption of internal marketing practices can increase the engagement of researchers in the protection and TT processes, facilitating dialogue with the productive sector and boosting the competitiveness of agribusiness in Espírito Santo. Internal campaigns, specific training, and the dissemination of success stories are some of the actions that can be adopted to

strengthen this culture and encourage the active participation of researchers in the protection and commercialization of their innovations.

LITERATURE REVIEW

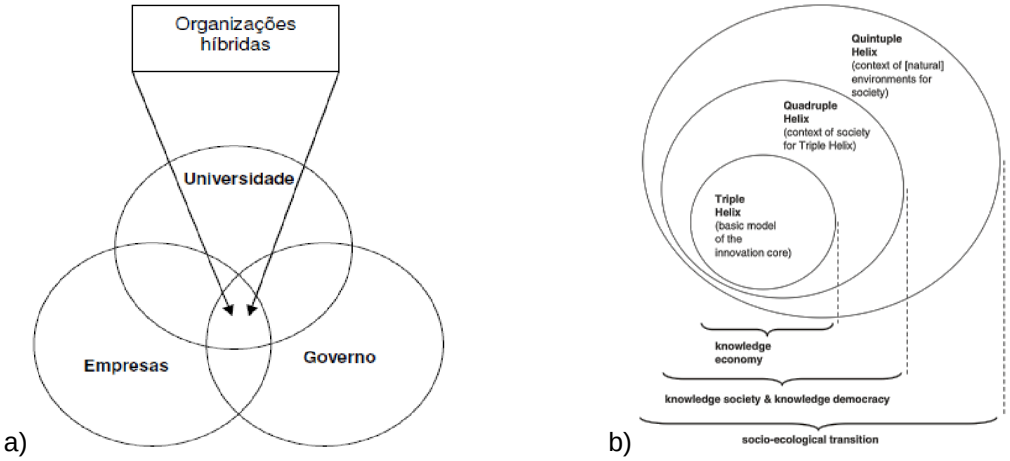
CHALLENGE OF ITCS AND NITS IN BRAZIL

ICTs in Brazil still face challenges to streamline TT and make this perspective frequent and effective, in their processes, define good practices and carry out marketing applications. Data from the National Forum of Innovation and TT Managers (Fortec), referring to the year 2023, reveals that only 23.8% of 130 NITs (146 scientific institutions in the country) were able to sign new licensing contracts. (Goebel, 2024). With just over 20 years of the Innovation Law in force, having such a low number, and these conditions allow us to affirm that institutions must fight to structure their NITs, in order to see them more effective and successful in technology licensing (Barbosa *et al.*, 2019, p. 506).

A "good remedy" to treat this chronic problem, according to Santos and Coutinho (2024) is the struggle for the continuous expansion of the culture of innovation, leveraging training processes with researchers, academics, civil servants in general, and of course, with external partners, perhaps in sectors such as agriculture, where the connection between ICTS and the productive sectors can be fragmented.

According to Etzkowitz and Leydesdorff (2000 and 2025), the consolidation of the Triple Helix model (FIGURE 1a), which integrates university, government, and the productive sector, requires continuous and dynamic interaction of the connection between research institutions and productive sectors, to transform academic knowledge into practical innovation. And practical innovation needs to work fluidly and depends on strategic alignment, on trained innovation actors, because training contributes to overcoming cultural and structural barriers that hinder innovation. However, contemporary innovation requires more participatory approaches, inspired by and adopting the Quadruple Helix model (Carayannis and Campbell, 2009) and the Fivefold Helix (Carayannis and Campbell 2010) (FIGURE 1b). These authors teach us that the Fourfold Helix expands the Triple Helix model by incorporating a fourth essential element: society. More specifically, this fourth helix is represented by the "media and culture-based public," encompassing not only civil society but also sectors such as the media, creative industries, cultural values, lifestyles, art, and even the conception of a "creative class." In this way, the model expands the understanding of innovation by considering the sociocultural impact on the generation and dissemination of knowledge.

FIGURE 1. a) Triple helix model of university-business-government relations and b) Triple Helix, Quadruple Helix and Quadruple Helix models.



Source: a) Model adapted from Etzkowitz and Leydesdorff (2000) and b) Source: Carayannis and Campbell (2009; 2010)

Subsequently, Carayannis and Campbell (2010) proposed the Fivefold Helix (FIGURE 1b), which advances over the Fourfold Helix by including a fifth fundamental element: the environment. This model recognizes the relevance of natural ecosystems for sustainable development, integrating the environmental dimension into the innovation process. Thus, the Fivefold Helix offers an interdisciplinary and transdisciplinary analytical framework, allowing a more comprehensive approach to innovation, sustainability, and social ecology. In times of serious environmental challenges, climate change, and growing scarcity of natural resources, innovation needs to go beyond technological advancement and incorporate sustainable and inclusive commitments by integrating society in the generation, appropriation, and circulation of knowledge, stimulating practices that reconcile economic development, social responsibility, and environmental preservation (FIGURE 1b).

It is important to demonstrate by example that if the State declares investments in emerging sectors, such as biotechnology, precision agriculture (PA) and renewable energies (NEVES, 2024), they make it possible for institutions that are part of the State, or that will be partners of it, to hold bids to encourage and oxygenate entrepreneurship and innovation with ambitious projects to cover these demands.

THE EVOLUTION OF NITS IN THE FACE OF LEGISLATIVE CHANGES: IMPACTS AND LIMITATIONS

With the advent of the Federal Innovation Law No. 10,973/2004 and its amendments, ICTs take advantage of the "wave" of regulation, with a significant paradigm shift regarding the incentive to create an NIT for each ICT (at least that), and between 2006 and 2014, the number of NITs in Brazil went from 43 to 266 (PIMENTEL, 2010; SILVER, 2014; VASCONCELOS and MEDEIROS 2018). While Torkomian (2009) contributes to studies of

performance indicators of the NITs, Cavalcante (2024) highlights the need to strengthen the NITs to promote entrepreneurship and TT, which denotes that public policies are slowly being implemented, in the wake of the update of the legal framework concerning Innovation.

The legislative contributions from Law 13,243/16 and Decree 9,283/18 provide profound transformations, and delegating to the NITs, governance in some of their main missions are: protecting the intangible assets developed in their respective institutions (ICTs); establish partnerships with the business sector, and joint development, Open Innovation (Chesbrough, 2003) and TT are very pertinent, to encourage entrepreneurship actions and other skills to support the Innovation Policy of the local ICT, involving the strategic use of knowledge flows, increasing the competitiveness of organizations.

In fact, as of Decree No. 10,534, of October 23, 2020, which institutes the National Innovation Policy, it is expected that academies and other entities will be able to carry out more integrated and strategic actions with *stakeholders*[11], as this is what is expected as a result of legislative updates (effects of the aforementioned Decree, added to Law No. 13,243/2016 and Decree No. 9,283/2018), that bring a significant influence to ICTs, forming collaborative networks between universities, companies and governments. In this sense, Dias and Porto (2014) emphasize that the strengthening of public policies is crucial and it is up to us to make better efforts to enable the connection between the academic, productive and governmental sectors, for results in TT and innovation.

According to Gordon and Cassiolato (2019), given the role of the State in financing technological innovations in strategic sectors, we have seen governments without defining clear priorities and diffuse focus, and the NITs are projected in an attempt to maintain numbers and goals, with little guidance for the perspective in TT. And recent understandings, such as the research by Marchini and Pereira (2019), public ICTs grew by 63.07% between 2009 and 2017, while private ICTs grew by 226.92% in the same period, with information on the IP Policy of Scientific, Technological and Innovation Institutions in Brazil, together with the MCTI (BRASIL, 2024).

In the view of Marchini and Pereira (2019), identifies bottlenecks, it is worth pointing out the timid participation of ICTs in the exploration of resources with technology contracts, and it is very common for ICTs to fall short of the proposed interaction capacity. This difficulty in interaction can be partially explained by the need to strengthen the role of NITs in TT, as provided for in Innovation Law No. 10,973/2004, which regulates the role of ICTs in

[11]Stakeholders, which refer to individuals, groups, or organizations that have an interest in or are directly or indirectly impacted by the activities, decisions, or results of a company, project, or initiative.

this process (Dias; Ventura; Bueno, 2023). Another relevant point is the identification that ICTs should adopt a greater commitment to innovation policies. Thus, we will demonstrate below, that the present work will highlight that the Technological Showcase needs to be this strong tool for access and broad transparency to data. In addition, to encourage the private sector, including enterprises linked to the ICT Incubator, to value the application of IP protections. This immersion in the universe of the Incubator is convenient, as Porto *et al*. adduce. (2021), to combat another problem, that is, the problem of non-entrepreneurial culture.

In view of the analysis of the slow evolution of NITs since the advent of Federal Innovation Law No. 10,973/2004, considering its substantial changes with Law 13,243/16 and Decree 9,283/18, it is worth studying what we have of evolution in the Espírito Santo context, according to data found on the web, and therefore, the cut of public ICTs in Espírito Santo, that stand out as innovation environments that considerably leverage the protection of IP assets, and engender efforts for technology transfer and commercialization.

In 2023, Ufes achieved a record 55 IP filings with the BPTO, including 10 trademarks, 27 patents, 17 computer programs and 1 industrial design. In addition, five patents were granted, reinforcing the university's progress in innovation, reflected by the 10th place in the Folha University Ranking (RUF 2023, Ufes, 2024). Confirmed by the registration of FORMICT Forms (2023), Ifes strengthened its IP actions through a technical cooperation agreement with the BPTO, enabling mentoring and training. By the end of 2024, Agifes (TABLE 1) had accumulated 116 patents filed, 119 computer program registrations, 12 trademarks, 8 industrial designs and, for the first time, 4 cultivars.

Table 1 - Comparison of IP filings by Agifes, between the years 2023 and 2024

IP Asset	2023	2024	Change (%)	Consolidated deposits
Patent	12	9	-25,0%	116
Computer Program	13	14	7,7%	119
Brand	2	6	200%	12
Cultivate	-	4	New record in 2024	4
Industrial design	-	-	-	8

Source: Agifes (2025).

ICTS AND NITS REFERENCES IN THE COUNTRY AND A BRIEF ANALYSIS OF SUCCESS TO SUPPORT NITS THAT SEEK TO PERFORM

According to the Oslo Manual (2006, p. 40), TT is an essential factor to boost innovation, as it allows the dissemination of knowledge among various agents of the productive ecosystem. This process can occur in different ways, including patent licensing,

collaboration in R&D projects, as well as informal interactions between researchers, companies and research institutions, mobility of specialists, presence of technological "sentinels", who keep up with technological and scientific advances.

A relevant example is the structure developed by the Innovation Agency of the University of São Paulo (USP), which operates in support and TT and is a reference as ICT in the country. According to information extracted from the studies by Dias and Porto (2014, p. 497), obviously, the sequence of administrative acts for TT contracts has some variations (FIGURE 2), in view of the decision to transfer with or without exclusivity. If the decision is to transfer WITHOUT exclusivity, the agents already have the training to expedite a call on the website to inform the TT opportunity, and prepare to negotiate the draft of the contract with the interested companies, defining, for example, the *upfront* with the fixed value with the technology, usually to cover development costs, deposit of the patent, consultancy of the researcher and market value, defining royalties that may be fixed for billing.

FIGURE 2. Characteristics of USP licensing agreements with and without exclusivity.

Contratos com exclusividade	Contratos sem exclusividade
Uma única empresa poderá explorar comercialmente a patente no mesmo território e/ou para o mesmo fim.	Qualquer empresa pode explorar comercialmente a patente no mesmo território e/ou para o mesmo fim.
A minuta do contrato não é negociável.	A minuta do contrato pode ser negociada junto à Agência USP de Inovação.
Vence a empresa que apresentar a maior pontuação apurada mediante a aplicação dos critérios do edital.	A empresa que apresentar a Declaração de Interesse, bem como as comprovações de Regularidade Jurídica e Fiscal está apta para explorar a patente.
Inclui, em geral, entre 4 e 8 horas de consultoria do pesquisador no total.	A empresa pode negociar a quantidade de horas que deseja receber a título de consultoria do pesquisador.

Source: Prepared by Dias and Porto, based on data collected in the interviews (2014, p. 498)

Still under the analysis of the rich contributions of Dias and Porto (2014, p. 497), after the patent application is filed, the commercialization stage begins, with simplified market analysis in the technology and technological marketing efforts. The objective is to give commercial visibility to the creations that the agency has to transfer. To speed up the procedures, it is very prudent for the Administration to use the practice of involving professors in the commercialization phase. It is already a very frequent practice in American universities, and why can't we involve professors in the practices of NITs in Brazil and Espírito Santo? What motivates the involvements is the great possibility of seeing professors well positioned to identify potential companies interested in licensing and because due to their expertise they become important partners for companies that wish to absorb the technology. (Siegel; Wadman; Link, 2003).

The Federal University of Minas Gerais (UFMG) is also at the top of the reference institutions, and its NIT undeniably has a high capacity for managing IP assets, known as the Coordination of Technological Transfer and Innovation - CTIT, which deserves to be

always observed, also standing out in the commercialization of technologies. (Garnica and Torkomian, 2009). The case of Unicamp in the national and Latin American scenario is impressive, as it published on 09/18/2024 that it reached a historic milestone by registering 212 active TT contracts. Everything then leads them, deservedly, to raise more than R$ 237 million in funds for projects, remaining the leader in patent applications in the state of São Paulo and third among universities in Brazil, according to the *ranking* of patent applicants by the BPTO. The website also mentions that an annual report by Inova Unicamp highlighted that the university has a portfolio of 1,295 patents in force, with 51 patent filings in Brazil and 17 abroad in 2023 alone. In addition to IP protection, Unicamp is a reference in innovation and entrepreneurship, being the second most entrepreneurial university in Brazil, according to the Entrepreneurial Universities Ranking (RUE) (Domingos; Garcia; Ribeiro, 2018; SP Agency, 2024; B.nano, 2025)

Some cases of high-concept ICTs and a reference for innovation ecosystems in the country, it is worth remembering that Embrapa is a model of rapid absorption of innovation in the agricultural sector at the national level, with a strong southeastern regional influence, being an example that obliges ICTs to follow its steps, and recognize it as one of the main players in RD&I, which provides excellent aid to rural producers, family farmers, as well as cooperatives. And thanks to their actions, the adoption of innovative technologies aimed at productivity and sustainability is leveraged in this environment, in addition to reducing the time between the development of technologies and their application in the production environment, even in the face of high investment costs and the constant need for training of the workforce to deal with digital tools and automation (Viola; Mendes, 2022).

INSTITUTIONAL POLICIES FOR TT: CAPACITY BUILDING, NEGOTIATION AND IMPACT

Following the line of discussion of public and private investments in innovation, we now cite Cimoli, Dosi and Stiglitz (2015), as well as Arbix *et al.* (2017), aiming to boost, catalyze the promotion in favor of innovation in the country, through a body of policies, programs and public instruments for risk sharing, stimulating and promoting technological advancement known as *catching up*[12] " and the dynamization of their economies, so that they are not technologically overtaken by competing countries".

CAPACITY BUILDING AND GOVERNANCE IN NITS

[12]A dynamic process in which developing countries, regions, or companies seek to reduce technological, economic, and industrial gaps with global leaders by absorbing, adapting, and improving advanced technologies, knowledge, and practices.

In order for ICTs to advance in the process of prioritizing policies for the protection of IP assets and TT, it is essential to implement continuous training programs for civil servants on *campuses*, to involve them in the daily dissemination of the culture of innovation, in the daily routine that evaluates conditions to build a bridge between institutional research and the market, in the tasks of procedural structuring dedicated to TT, in the day-to-day negotiation of assets, among other possibilities (Cimoli, Dosi and Stiglitz, 2015). The knowledge of the teams about the weaknesses of the structures of the NITs, including the need to overcome bureaucratic barriers that often limit the potential for innovation and commercialization of technologies, to remind us that universities and research centers need to have very clear institutional policies for the granting of technologies, and need to align the demands with the market (Tibércio *et al*, 2024; Desidério and Zilber 2014, p.104; Etzkowitz and Leydesdorff 2000 and 2025).

STRATEGIES FOR TRADING AND COMMERCIALIZATION OF TECHNOLOGIES

The idea is to make civil servants, researchers and managers of the NITs also understand the various legal and administrative instruments, plan and establish a path for advances in research, licensing, and preparation for negotiation that leads them to success in TT. To this end, training should not be seen only as an operational support, but as an essential strategy to ensure legal certainty; which, in turn, leads to greater confidence of the professional, and this strengthens the performance in the NITs. In addition, the AGU's collection of legal models (2024) offers an important reference for the structuring of contracts, partnerships, and legal instruments, as provided for in the Legal Framework for Science, Technology, and Innovation.

Providing training to equip NITs is a measure that strengthens the role of NITs as facilitators of innovation and reduces bureaucratic obstacles in the TT process. Thus, Desidério and Zilber (2014, p. 109) affirm the convenience of innovation agencies monitoring projects developed by technology-based incubators established within universities, with the objective of transferability to the market and society, and indicate the dependence on communication with the market itself. There is a strongly deepened effort and dedication in research, and the same effort is not continued until the "transfer of innovation" result.

It is necessary to be willing to observe strategies that have been developed for other fields of scientific knowledge, and to improve processes with multidisciplinary teams. The arduous mission of NITs in facilitating the interaction between academia and the market is wisely pointed out by Goebel *et al*. (2024), in the discipleship of Soares and Torkomian

(2021). In the context of the health area, they point to gaps in knowledge in relation to emerging countries such as Brazil, and as the development and strategies of TT are the preserve of competence to the NITs, promoting and negotiating in the relationship with companies, are actions that may not advance if there is no engagement from other environments (GOEBEL *et al*., 2024).

It is worth paying attention to a sequence of procedures mentioned by Barbosa *et al*. (2019, p.508-509), covering the subject "good practices in IP and TT management and the performance of ICTs", in the connection between universities and companies, seeing as a common point mutual benefits between University and Companies, following institutional policies and establishing preparation for project management. The checklist needs to follow the sequence: (1) of the motivation of companies, for cost reduction and access to qualified personnel, while in Universities there is the motivation of additional resources to improve the use of equipment and generate a virtuous cycle for research. In another step (2), in relation to the obstacles for companies, it is the identification of the need for technologies appropriate to the objectives, mapping whether the results are embryonic or not, observation of the infrastructure for research and quality in the laboratories, deadlines, continuity (commitment), security, confidentiality, in addition to the important mapping of the lack of intermediation mechanisms and access to information. (3) There can be no distance between the objectives of the project and the marketing actions, and there must be a range of criteria for licensing, prices and royalties, and it is important that the procedural movement is not time-consuming, and considers culture and language.

Still in line with the understanding of Barbosa *et al*., (2019, p.508-509), with regard to facilitators in the view of companies, it is noted that the bibliographic review covers everything that surrounds invention, including trust in scientists, formal instruments, the preparation of entrepreneurs, the use of laboratories and university services. And when it makes the explanation dedicated to the needs for academic *spin-offs*, it considers investments in R&D, qualified staff, high education, high innovation, interaction with other companies. To the point of dealing specifically in the ETTs, academic, commercial and management expertise, adaptable contracts, emphasis on generating economic value, proactivity and support teams, participation of the inventor in TT, in the marketing of technology and in the transfer of tacit knowledge to companies (knowledge transfer).

Therefore, it is clear that Barbosa *et al*. (2019, p.508-509) mention a series of steps to be completed, understanding that the participation of the inventor and the team beyond the ETTs is fundamental for the success of TT. Chart 1 presents what was essentially explained above, highlighting the need for an efficient organizational structure, continuous

training of teams, clarity in institutional policies, and improvement of strategies for commercialization of technologies, according to the national literature. In addition, it shows difficulties in valuing assets, negotiating with the market and overcoming bureaucratic barriers, factors that directly impact the effectiveness of TT and the interaction between ICTs and the productive sector.

Table 1. Best Practices, as per justifications and references for NITs

Practice	Short description	Rationale and Benefits	References
Continuous training of civil servants, including training with an emphasis on legal instruments	Training in TT, asset trading; other procedures. Training in Administrative Law and adoption of legal models of the AGU;	It promotes the professionalization of civil servants, improves the efficiency of processes and reduces errors in TT. It ensures legal compliance in contracts, reduces legal risks and facilitates the implementation of the ST&I Legal Framework.	Cimoli, Dosi and Stiglitz (2015); AGU (2024); ST&I Legal Framework
Governance and structure of NITs	Clear policy setting, efficient organizational structure	It facilitates decision-making, reduces bureaucracy and improves coordination between ICT sectors.	Tiberius *et al*. (2024); Desiderius and Zilber (2014)
Negotiation and commercialization of technologies	Improvement of strategies for licensing and valuation of assets	It improves communication with companies, accelerates negotiations and maximizes the economic potential of innovations.	Cunningham, Harney and Fitzgerald (2021)
Partnerships and interaction with the market	Fostering collaboration between ICTs, companies and investors	It expands marketing opportunities, strengthens innovation networks and attracts investments.	Goebel *et al*. (2024); Soares and Torkomian (2021)
Monitoring and impact evaluation	Creating metrics to assess the effectiveness of TT and IP	It allows you to evaluate the impact of the transferred technologies, identifying points of improvement for future partnerships.	Barbosa *et al*. (2019, p. 508-509)

Source: Dissertation Team

Making a simple comparison of our reality of the TTOs that are the object of study by Cunningham, Harney and Fitzgerald (2021), observing the context of structuring and governance, strategic actions of the TTOs, among other aspects detailed below.

You don't do trading in the interaction with the market as you should, if at all. This is because innovation agencies have shown to face many barriers and objections that permeate negotiation, including difficulties in valuing assets, which are sometimes also overlooked. Cunningham, Harney, and Fitzgerald (2021) highlight that the effectiveness of Technology Transfer Offices (TTOs) can depend on the most diverse strategic and

operational factors. Keeping the due proportions, the circumstances of the TTOs in the United Kingdom are similar to the NITs in Brazil, and expose that we need an adequate organizational structure, clear policies, and well-defined procedures. Among the main similarities between the TTOs in the United Kingdom and the NITs in Brazil, the institutional roles, the role of intermediary in the TT between academia and the market, and the confrontation of challenges in the organizational structure should be highlighted.

It is essential to train the team in specific skills, such as negotiation techniques, asset valuation, training for good practices and the sequence of very reliable steps (procedures), the choices of strategies that can be drawn from the first dialogues with future beneficiaries. Lack of familiarity with these techniques for trading and valuing IP assets can be a significant barrier to effective technology transfer. It is important to say that Cunningham, Harney, and Fitzgerald (2021, p. 9) teach us that several national initiatives among EU Member States have promoted advances and drive the improvement of TT skills among the stakeholders involved in this process. An example of these initiatives is the *Progress TT Capacity Building for Technology Transfer*[13], funded under Horizon 2020, a program succeeded by Horizon Europe (2021-2027).

TT is a process that requires high interaction between people and demands a broad and specialized set of skills, and given the complexity of issues that permeate IP and TT, it requires specific legal knowledge, as well as commercial and scientific skills to position the importance of technological development. Therefore, to carry out a licensing, it is recommended to study the market, plan marketing and the crucial points of the negotiation. The effective performance of TTOs/NITs requires a diverse set of skills, from brokerage skills and identification of market niches to the creation of companies, spin-offs, in addition to demonstrating to the market the need to adapt to technological demands. Building networks and the ability to connect different stakeholders are crucial to driving TT, requiring continuous training and strategies that strengthen the interaction between university and market.

It may be common to observe that many institutions carry out actions involving licensing or offering technology with reactive behavior for most of their negotiations, and this may be common in public institutions renowned in the field of innovation, as identified by Goebel (2024) in his studies by Fiocruz-Paraná. This reactive form can be based on specific demands arising from the requests of researchers, or through opportunities for external calls for funding.

[13] Horizon Europe: succeeds Horizon 2020 as the main funding program of the European Union (EU), running between 2021 and 2027, dedicated to research and innovation.

However, it is necessary to prepare every commercial structure with multiple competencies, to go beyond the legal profile in contractual formalization. Teams need to equip themselves with initiatives to approach companies or strategic technological marketing actions. Otherwise, they will be devoid of minimum knowledge about the technologies, depending on inventors participating in fairs in the areas of inventions, as well as collaborating in the dissemination of the institution's innovation portfolio. Prospecting and seeking partnerships and other forms of active and coordinated searches need to take place to leverage the results of NITs.

EVOLUTION OF THE IFES INNOVATION POLICY: THE (RE)STRUCTURING FRAMEWORK AND WHAT IS EXPECTED IN THE FACE OF CHALLENGES AND OPPORTUNITIES FOR TECHNOLOGY TRANSFER.

The old Ifes Innovation Policy, instituted by the Resolution of the Superior Council No. 53, of July 24, 2012, already brought certain concerns in regulating IP rights, support for entrepreneurship and innovation habitats, tax incentives of the good law, provision of services and many other tools and strategies arising from national legislation. The guidelines established by policy No. 53/2012, which already regulated the rights and duties related to Intellectual and Industrial Property, advising on the importance of integrating research efforts with the search for external partnerships and potential investors.

Currently, Ifes has a new Innovation Policy, with one of the main objectives of strengthening partnerships between academia and industry to facilitate TT, in addition to envisioning planning and the need to contribute and strengthen local structures and equipment (local and regional action in areas of influence of the *campuses*), implementing Innovation and Intellectual Property Centers (NIPIs) and promoting collaborative spaces, as well as expansion and adaptation of laboratory structure, so that researchers, students and partners can develop technological and social-based projects.

With the approval of the new Innovation Policy (CONSUP/IFES Resolution No. 289, of October 18, 2024), which covers innovation, IP and TT resulting from the scientific and technological production of Ifes, it becomes even more urgent to promote greater awareness among researchers. It is essential that they understand the strategic role of Ifes in consolidating its Research, Development and Innovation (RD&I) initiatives and that they are prepared to act in all stages of the innovation process, including negotiation with partners and investors, aligning with institutional objectives.

In the context of Agifes' efforts to lead the review of the institutional innovation policy in a Commission process with a broadly representative formation, it is proposed that the

new policy be more comprehensive and promote effective institutional communication strategies, which is expected with the advent of Resolution No. 289/2024 and ancillary rules that Agifes intends to approve, making networking more strengthened, and establishing clarity with issues related to ownership and participation in the results of the exploitation of intellectual creations. The Federal Institute of Espírito Santo (Ifes) has a wide network, currently composed of 25 units, (23 of which *are campuses*, Cefor (Ifes Reference Center for Training and Distance Education) and Innovation City), with wide distribution in Espírito Santo, and the profusion of engaged innovation environments can make us infer that Ifes has strongly awakened to the mission of disseminating knowledge and innovative technologies.

In view of this, the institution needs to ensure that researchers and managers intensify their understanding and incorporate IP and TT protection mechanisms into their academic routines, as well as into the routine of project development. In addition, the need to strengthen the articulation with the productive sector demands a more active posture of the institution in the construction of strategic collaboration networks, as well as in the training of its professionals to act in processes of negotiation, licensing and economic exploitation of the technologies developed, effecting the implementation of the current policy to overcome the cultural challenges mentioned above.

The structuring of innovation environments at Ifes and the strengthening of Agifes should contribute to the appreciation of applied research, enhancing the capture of investments and the generation of socioeconomic impact. Thus, it is expected that the new policy will not only modernize institutional innovation instruments, but also foster an entrepreneurial mindset among researchers and students, consolidating the role of Ifes as a strategic hub for TT and the development of innovative solutions.

As explained elsewhere, the update of the Legal Framework for Innovation in Brazil in 2016 brought significant advances, reflected in the new Ifes Innovation Policy, which seeks to make IP protection mechanisms more agile. These changes aim to stimulate the creation of startups and the active participation of researchers in the innovation process. Among the improvements, Ifes has sought to highlight the strengthening of entrepreneurship, the structuring of innovation environments, the expansion of internationalization actions and the implementation of incentives so that researchers can dedicate themselves with great conviction and encouragement to innovative activities.

ALIGNMENT OF TECHNOLOGY TRANSFER WITH THE DEMANDS OF THE PRODUCTIVE SECTOR

The wide territorial distribution of Ifes, combined with the growing structuring of its innovation environments, represents another strategic opportunity for TT in a decentralized way and adapted to local specificities, so it is imperative that the management of all environments aligns interests. Given the possibility of exploring its capillarity to work with various strategies, it is interesting to apply knowledge and technological solutions both in urban areas and in rural communities, expanding the reach and effectiveness of the innovations developed.

In this context, the alignment between academic production and the demands of the productive sector becomes a determining factor to consolidate the role of Ifes as a promoting agent of economic and social development, and from the strengthening of institutional partnerships and the improvement of IP protection and commercialization mechanisms, it is sought to enable TTs that directly meet the needs of different productive segments, boosting competitiveness and innovation in the state of Espírito Santo.

One of the main obstacles is ensuring that researchers and managers understand and incorporate the mechanisms of IP and TT protection into their academic routines. In addition, the need to strengthen the articulation with the productive sector demands a more active posture of the institution in the construction of strategic collaboration networks, as well as in the training of its professionals to work in negotiation, licensing and economic exploitation processes of the technologies developed. TT plays an essential role, acting as a platform that facilitates the exchange of knowledge between researchers, farmers, companies and educational, research, extension and development institutions, promoting the adoption of sustainable and innovative practices.

And Ifes always needs to reevaluate its normative acts, aiming to consolidate its essence as an integrated institution and promoter of teaching, research, extension and innovation, and it is essential that its actions in Research, Development and Innovation (RD&I) are guided by an institutional policy that values the challenges and opportunities of agribusiness in Espírito Santo. In the case of ginger, for example, the integration of RD&I efforts can drive significant results, contributing to the development of technological solutions, IP protection, and TT. Such actions not only strengthen the regional productive sector, but also promote the competitiveness and sustainability of agribusiness, aligning with the strategic role of Ifes in fostering socioeconomic progress through innovations that benefit society as a whole.

These efforts aim to generate new knowledge, create practical solutions, and implement improvements in processes, products, or services, contributing to competitiveness and technological progress. In Brazil, initiatives such as the Innovation Law (Law No. 10,973/2004) and the regulation of sectoral funds have sought to boost investment in RD&I, recognizing its relevance for socioeconomic development (ANPEI, 2025).

In view of this, the need to create didactic materials that could act as communication bridges was perceived, facilitating understanding and interaction between academia, government and the productive sector. This gap, observed during the trajectory of the current author of this dissertation in management, reinforced the commitment to develop practical and strategic solutions to improve communication for greater efficiency in the protection of IP assets and for future TT at Ifes, which is the main motivation for carrying out this study within the scope of the Professional Master's Degree in IP and TT for Innovation (Profnit).

FINAL CONSIDERATIONS

This study revealed the complexity and strategic relevance of Intellectual Property (IP) and Technology Transfer (TT) for the Brazilian innovation ecosystem, centered on the context of Science and Technology Institutions (ICTs) and Technological Innovation Centers (NITs), especially at the Federal Institute of Espírito Santo (Ifes). The analysis made it possible to identify structural challenges, legislative progress and good practices that guide the management of innovation in public ICTs.

The adoption of the Triple, Quadruple, and Quintuple Helix models emphasized the need for multisectoral integration (universities, government, industry, society, and the environment) to transmute scientific knowledge into socioeconomic impact. The case of Agifes exemplified how the articulation of these actors can amplify TT, but there are still gaps in the articulation with the productive sector.

It allowed some recommendations to be made for the Brazilian Ifes and ICTs, such as: Strengthen Governance, implementing institutional policies that respect the Legal Framework for Innovation, with governance rules that include clear metrics to measure the impact of TT Promote training in negotiation, intellectual property and technological marketing, to include not only NITs but also researchers and students. Execute internal marketing campaigns to sensitize the academic community to the impacts of IP, using success stories as a stimulus. Establish collaborative networks with local companies and

strategic sectors, in the Embrapa model, which minimizes the time between research and practical application.

CONTRIBUTIONS AND FUTURE PROSPECTS

This work creates a theoretical-practical basis for NITs in formation, such as those of Ifes, by bringing a synthesis of the challenges and solutions based on the evidence so far. In terms of future perspectives, it is recommended to carry out: Comparative studies of public and private ICTs in order to find efficiency gaps; The analysis of the impact of the new Ifes Innovation Policy (CONSUP Resolution 289/2024) in the coming years; The development of market intelligence tools to connect research to the demands of the productive sector.

In summary, the conversion of scientific knowledge into innovation requires a set of integrated actions with qualified human resources and an institutional commitment. The competition of the challenges raised may make Ifes and other Brazilian ICTs catalyzing actors for the development of the regional and national in a strategic vision.

REFERENCES

1. ABREU, A. M. F. de; MATOS, H. T. de. Use of design thinking as a prototyping tool for the technological showcase of NIT-UFMA. Cadernos de Prospecção, Salvador, v. 16, n. 1, p. 161-177, jan./mar. 2023. Available at: https://doi.org/10.9771/cp.v16i1.49291. Accessed on: 18 nov. 2024.

2. SP AGENCY. Unicamp breaks record with 212 active technology transfer contracts. 18 Sep. 2024. Available at: https://www.agenciasp.sp.gov.br/unicamp-bate-recorde-com-212-contratos-ativos-de-transferencias-de-tecnologias/. Accessed on: 9 mar. 2025.

3. ANPROTEC; MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION; TECHNOLOGICAL DEVELOPMENT SUPPORT CENTER. Study of practices of technology parks and business incubators. Brasília: Anprotec, 2015. Available at: https://anprotec.org.br/site/wp-content/uploads/2020/06/EstudoMelhoresPraticasParquesIncubadoras.pdf. Accessed on: 28 Feb. 2025.

4. ANPROTEC. Mapping of the mechanisms for generating innovative enterprises. Brasília: Anprotec, 2019. Available at: https://www.feevale.br/Comum/midias/e46b2a7c-b1a5-4f15-b49f-b961901a2cee/anprotec-mecanismos-geracao-de-inovacao.pdf. Accessed on: 28 Feb. 2025.

5. ARBIX, G.; SALERNO, M. S.; AMARAL, G.; LINS, L. M. Advances, misconceptions and instability of innovation policies in Brazil. Novos Estudos - CEBRAP, São Paulo, v. 36, n. 3, p. 9-27, nov. 2017. Available at: https://doi.org/10.25091/S0101-3300201700030002. Accessed on: 8 nov. 2024.

6. BARBOSA, A. M. A.; BARATA, R.; BRAGA, E. de A. V.; ROCHA, A. M. da; ARAÚJO, A. L. C. de. An overview of innovation performance in Brazil and the search for good management practices in technology transfer (TT) in Science and Technology Institutions (ICT) in Brazil. Cadernos de Prospecção, Salvador, v. 12, n. 3, p. 504-522, set. 2019. Available at: https://periodicos.ufba.br/index.php/nit/article/view/27256. Accessed on: 18 nov. 2024.

7. B.NANO. Technologies. [S.l.]: B.Nano, [n.d.]. Available at: https://bnano.com.br/tecnologias/. Accessed on: 13 mar. 2025.

8. BRAZIL. Ministry of Management and Innovation in Public Services. Electronic Auction No. 90001/2025. Available at: https://www.comprasnet.gov.br/acesso.asp?url=/edital-158151-5-90001-2025. Accessed on: 11 mar. 2025.

9. BRAZIL. Decree No. 9,283, of February 7, 2018. Regulates Law No. 10,973, of December 2, 2004, and Law No. 13,243, of January 11, 2016, which provide for stimuli to scientific development, research, scientific and technological training, and innovation. Official Gazette of the Union, Brasília, DF, 8 Feb. 2018. Available at: https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/decreto/d9283.htm. Accessed on: 8 nov. 2024.

10. BRAZIL. Decree No. 10,534, of October 23, 2020. Establishes the National Innovation Policy. Federal Official Gazette, Brasília, DF, 23 Oct. 2020. Available at:

https://www.in.gov.br/en/web/dou/-/decreto-n-10.534-de-28-de-outubro-de-2020-283444841. Accessed on: 8 nov. 2024.

11. BRAZIL. Law No. 9,279, of May 14, 1996. Regulates rights and obligations related to industrial property. Diário Oficial da União, Brasília, DF, May 15, 1996, p. 8353-8369. Available at: http://www.planalto.gov.br/ccivil_03/leis/l9279.htm. Accessed on: 20 jan. 2025.

12. BRAZIL. Law No. 10,973, of December 2, 2004. Provides for incentives for innovation and scientific and technological research in the productive environment and provides for other provisions. Diário Oficial da União, Brasília, DF, 3 dez. 2004. Available at: https://www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/lei/l10.973.htm. Accessed on: 8 nov. 2024.

13. BRAZIL. Law No. 13,243, of January 11, 2016. Provides for stimuli to scientific development, research, scientific and technological training and innovation, and amends Law No. 10,973, of December 2, 2004, and other provisions. Diário Oficial da União, Brasília, DF, 12 jan. 2016. Available at: https://www.planalto.gov.br/ccivil_03/_ato2015-2018/2016/lei/l13243.htm. Accessed on: 8 nov. 2024.

14. BRAZIL. Ministry of Science, Technology and Innovation. Form on Intellectual Property Policy of Scientific, Technological and Innovation Institutions of Brazil (FORMICT). Brasília, DF, [n.d.]. Available at: https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/propriedade-intelectual-e-transferencia-de-tecnologia/arquivos/relatorio-formict-2024_ano-base-2023.pdf/view. Accessed on: 11 mar. 2025.

15. BRAZIL. Complementary Law No. 182, of June 1, 2021. Establishes the legal framework for startups and innovative entrepreneurship; and amends Law No. 6,404, of December 15, 1976, and Complementary Law No. 123, of December 14, 2006. Federal Official Gazette, Brasília, DF, June 2, 2021. Available at: https://www.in.gov.br/en/web/dou/-/lei-complementar-n-182-de-1-de-junho-de-2021-323558527. Accessed on: 5 jan. 2025.

16. BUENO, Alexandre; TORKOMIAN, Ana Lúcia Vitale. Licensing and commercialization rates of technologies for technological innovation centers based on good international practices. Encontros Bibli: Electronic Journal of Library Science and Information Science, v. 23, n. 51, p. 95-107, 2018. Available at: https://www.redalyc.org/journal/147/14753783008/movil/. Accessed on: 16 mar. 2025.

17. CARAYANNIS, E. G.; BARTH, T. D.; CAMPBELL, D. F. J. Five-fold helix innovation model: global warming as a challenge and engine of innovation. Revista Direito, Inovação e Regulações, Cascavel, v. 1, n. 2, p. 89-111, May/Aug. 2022. Available at: https://periodicos.univel.br/ojs/index.php/redir/article/view/178. Accessed on: 1 mar. 2025.

18. CAVALCANTE, P. L. C. Dismantling innovation policy: strategies and causes in contemporary Brazil. Journal of Public Administration, v. 58, n. 1, e2022-0358, 2024.

19. CHESBROUGH, H. Open innovation: the new imperative for creating and profiting from technology. Boston: Harvard Business School Press, 2003.

20. CIMOLI, M.; DOSI, G.; STIGLITZ, J. The rationale for industrial and innovation policy. Public Service Journal, v. 66, p. 55-68, 2015. Available at: https://doi.org/10.21874/rsp.v66i0.1277. Accessed on: 16 jan. 2025.

21. COELHO, L. C. D.; DIAS, A. A. The UFPE Technological Innovation Center: an instrument of innovation policy or legal obligation? Journal of Administration, Accounting and Economics of Fundace, Ribeirão Preto, v. 7, n. 1, p. 64-79, 2016. Available at: https://racef.fundace.org.br/index.php/racef/article/view/181. Accessed on: 31 Dec. 2024.

22. DESIDÉRIO, P. H. M.; ZILBER, M. A. Barriers in the process of technology transfer between innovation agencies and companies: observations in public and private universities. Revista Gestão & Tecnologia, Pedro Leopoldo, v. 14, n. 2, p. 101-126, May/Aug. 2014. Available at: http://revistagt.fpl.edu.br/. Accessed on: 8 nov. 2024.
23. DIAS, A. A.; PORTO, G. S. How does USP transfer technology? Organizações & Sociedade, v. 21, n. 70, p. 489-507, 2014. Available at: https://www.scielo.br/j/osoc/a/j6fwvWpkBFRMtjsChKkLtfR/. Accessed on: 12 out. 2024.

24. DIAS, F. X.; VENTURA, R.; BUENO, M. P. Technology transfer in agriculture 4.0. Revista Observatorio de la Economía Latinoamericana, Curitiba, v. 21, n. 11, p. 21865-21887, 2023. Available at: https://ojs.observatoriolatinoamericano.com/ojs/index.php/olel/article/view/1448. Accessed on: 5 mar. 2025.

25. EMBRAPA. Technology transfer and innovation: strategies for sustainable development. [S.l.]: Embrapa, 2021. Available at: https://www.embrapa.br.

26. ETZKOWITZ, H.; LEYDESDORFF, L. The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. Research Policy, v. 29, n. 2, p. 109-123, 2000. Available at: https://doi.org/10.1016/S0048-7333(99)00055-4.

27. ETZKOWITZ, H.; LEYDESDORFF, L. Triple helix model of university-company-government relations. [S.l.: s.n.], [n.d.]. Available at: https://www.researchgate.net/figure/Figura-3-Modelo-da-helice-triplice-de-relacoes-entre-universidade-empresa-governo_fig3_262510200. Accessed on: 1 mar. 2025.

28. GARNICA, L. A.; TORKOMIAN, A. L. V. Technology management in universities: an analysis of patenting and the factors of difficulty and support for technology transfer in the State of São Paulo. Gestão & Produção, São Carlos, v. 16, n. 4, p. 624-638, Oct./Dec. 2009.

29. GOEBEL, K. Strategies for promoting technology transfer from a health research institution. 2024. Thesis (PhD in Biosciences and Biotechnology) – Graduate Program in Biosciences and Biotechnology, Carlos Chagas Institute, Oswaldo Cruz Foundation, Curitiba, 2024.

30. GOEBEL, K. et al. Offering technologies for innovation: strategies and challenges. Innovation & Management Review, v. 2, n. 1, p. 44-59, fev. 2024.

31. GORDON, José Luis; CASSIOLATO, José Eduardo. The role of the State in innovation policy from its instruments: an analysis of the Inova Empresa plan. Journal of

Contemporary Economics, v. 23, n. 3, e192334, 2019. Available at: https://www.scielo.br/j/rec/a/S49XgttsJL43z3QCnFyqFCt/. Accessed on: 25 Feb. 2025.

32. HEWITT-DUNDAS, Nola. Research intensity and knowledge transfer activity in UK universities. Research Policy, v. 41, n. 2, p. 262-275, 2012. Available at: https://doi.org/10.1016/j.respol.2011.10.010. Accessed on: 16 jan. 2025.

33. MARCHINI, E. L.; PEREIRA, M. F. The evolution of the Institutes of Science and Technology and their Technological Innovation Centers in Brazil. Cadernos de Prospecção, v. 12, n. 5, p. 1174, 2019. Available at: https://doi.org/10.9771/cp.v12i5.32804.

34. MINAS, R. B. A. de. The culture of intellectual property management in companies: an analysis of patent protection by small Brazilian technology-based businesses. 2018. Dissertation (Master's Degree in Intellectual Property and Technology Transfer for Innovation) – PROFNIT, University of Brasilia, Brasília, 2018.

35. MIT. Annual repository. [S.l.]: MIT, [n.d.]. Available at: https://tlo.mit.edu.

36. NEVES, H. C. The Lion's Awakening: Brazilian Leadership in the Energy Transition from the National Innovation System. 2024. Available at: https://repositorio.pucgoias.edu.br/jspui/handle/123456789/8382. Accessed on: 15 Jan. 2025.

37. PRATA, A. T. Lecture given on NITs. In: ENCONTRO DO FÓRUM NACIONAL DE GESTORES DE INOVAÇÃO E TRANSFER DE TECNOLOGIA - FORTEC, 8., 2014, São Paulo. Annals [...]. São Paulo: FORTEC, 18 May 2014.

38. PIMENTEL, L. O. Technological innovation centers: report on the analysis of forms for information on the Intellectual Property Policy of Science and Technology Institutions in Brazil. Brasília, DF: CGEE, 2010.

39. PERKMANN, M. et al. Academic engagement and commercialisation: a review of the literature on university–industry relations. Research Policy, v. 42, n. 2, p. 423-442, mar. 2013. Available at: https://doi.org/10.1016/j.respol.2012.09.007. Accessed on: 20 out. 2024.

40. PIETROVSKI, E. F. et al. Management methodology for technological innovation centers. Revista Gestão Inovação e Tecnologias, v. 10, n. 1, p. 1560-1575, jan. 2020. Available at: https://www.researchgate.net/publication/340775168_Methodology_of_Management_for_the_テクノological_Innovation_Centers. Accessed on: 6 out. 2024.

41. SANTOS, M. E. R. dos; COUTINHO, S. V. Innovation in Brazil. In: FRADE, Luis Cláudio S. (ed.). The history of innovation in Brazil: challenges and opportunities. 1. ed. Niterói, RJ: CTSMART, 2024. p. 20-44.

42. SANTOS SILVA, L. C. et al. The process of technology transfer in Brazilian public universities through technological innovation centers. Interciencia, v. 40, n. 10, p. 664-669, 2015. Available at: https://www.interciencia.net/volumen-40/numero-10-2/. Accessed on: 12 Dec. 2024.

43. SOARES, T. J.; TORKOMIAN, A. L. V. TTO's staff and technology transfer: examining the effect of employees' individual capabilities. Technovation, v. 102, 102213, Apr. 2021. Available at: https://doi.org/10.1016/j.technovation.2020.102213. Accessed on: 28 Dec. 2024.

44. TIBÚRCIO, F. C. da S.; GRANJEIRO, P. A.; GONÇALVES, M. M. D. Mapping the innovation developed in higher education institutions in the Campo das Vertentes mesoregion of Minas Gerais. Journal of Management and Secretariat, v. 15, n. 2, e3258, 2024. Available at: https://doi.org/10.7769/gesec.v15i2.3258. Accessed on: 25 Dec. 2024.

45. FEDERAL UNIVERSITY OF ESPÍRITO SANTO. Ufes has a record of patents granted and applications for registration of intellectual property. 2024. Available at: https://ufes.br/conteudo/ufes-tem-recorde-de-patentes-concedidas-e-pedidos-de-registro-de-propriedade-intelectual. Accessed on: 11 mar. 2025.

46. VASCONCELOS, A. J. de; MEDEIROS, J. C. C. Preliminary study of the stages of development of the Technological Innovation Centers (NIT): analysis of the balance between the activity of intellectual property protection and technology transfer. Strategic Partnerships, Brasília, DF, v. 23, n. 47, p. 49-62, jul./dez. 2018.

47. VIOLA, E.; MENDES, V. Agriculture 4.0 and climate change in Brazil. Environment & Society, v. 25, e02462, 2022. Available at: https://doi.org/10.1590/1809-4422asoc20200246r2vu2022L3OA. Accessed on: 5 mar. 2025.

48. WORLD INTELLECTUAL PROPERTY ORGANIZATION. World Intellectual Property Indicators 2020. Geneva: WIPO, 2020. Available at: https://www.wipo.int/about-ip/en/. Accessed on: 20 Feb. 2025.

49. ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT. Frascati Manual 2015: guidelines for collecting and reporting data on research and experimental development. Paris: OECD Publishing, 2015. Available at: https://www.oecd.org/publications/frascati-manual-2015-9789264239012-en.htm. Accessed on: 12 mar. 2025.

50. OECD/EUROSTAT. Oslo Manual: guidelines for collecting and interpreting innovation data. 3. ed. Paris: OECD Publishing, 2005. Available at: http://dx.doi.org/10.1787/9789264013100-en.