Innovation and intellectual property system: proposal for a conceptual framework

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Abstract

Developing a resilient infrastructure, inclusive and sustainable industrialization and fostering innovation correspond to one of the Sustainable Development Goals of the United Nations (SDG/UN), notably the ninth. However, meeting this result, in the case of developing countries such as Brazil, seems complex, demanding a review of the organization of industrial and innovation systems. Based on that, this study analyzes the panorama of Science, Technology and Innovation in Brazil (ST&I), through indicators. Then, a conceptual framework is presented with suggestions for planning and organizing an innovation and intellectual property system. The analysis of the country's indicators revealed some important challenges in the area of ST&I, such as the need to improve the financing process and better adhesion of national companies to the system of protection of their intellectual property. Additionally, the framework presented a series of suggestive actions for the system's actors, based on 05 main functions: Regulatory, Coordination, Protection of Intellectual Property, Promotion and Production and Operationalization of Knowledge.

Keywords: indicators; model and planning; Science, Technology and Innovation; ST&I; Brazil.

1. Introduction

Developing a resilient infrastructure, inclusive and sustainable industrialization and fostering innovation correspond to one of the Sustainable Development Goals of the United Nations (SDG/UN), notably the ninth. However, according to the Report of Progress toward the Sustainable Development Goals, since the pandemic, in the year 2021, the added value of the industry had one of the slowest growth rates since 2012, mainly due to the tax and trade tensions imposed by COVID-19 (ONU. Economic and Social Council, 2021). This is a complex economic framework, which demands a review of the organization of both the industrial system and the countries' innovation system.

Exploiting the benefits of innovation requires protecting knowledge against imitation, preventing or delaying inappropriate dissemination of the invention in relevant markets (Agostini et al., 2016), thus, intellectual property is an important resource in this sense. Negative effects of these resources arise if the costs of protecting and maintaining these assets exceed the benefits generated by the protection, or if the profit received through patents is less than the cost of supporting patent infringement claims (Schliessler, 2015). On the contrary, positive effects occur in the reverse situations.

Thus, intellectual property is a strategic resource for business organizations, especially industries, and, given the growing importance of these assets in the current knowledge economy, it should be used more intensively by companies from developing countries. However, these countries currently have a small number of patent applications of national origin and a large number of patents from multinational companies[1] (Cavalheiro & Brandao, 2017).

This movement is repeated in underdeveloped and emerging economies such as Brazil, for example. Currently, there is a small volume of applications of national origin at the National Institute of Intellectual Property (INPI), below the USA and Germany, and also a small volume of applications abroad (Cota et al., 2016). As a result, the INPI currently grants more patents to foreigners than to Brazilians, especially in areas that tend to leverage in the future, with high knowledge intensity, such as the health, chemical and biotechnological industry, for example. This fact suggests that the global standardization of rights of intellectual property, aiming to boost technological innovation, was an unsuccessful strategy in countries like Brazil[2] (Chiarini & Silva, 2016).

Thus, considering these general aspects, the present study will present an overview of Science, Technology and Innovation (ST&I) in Brazil, through indicators.

Then, based on the initial findings and the discussions held, a conceptual framework will be presented with suggestions for planning and organizing an innovation and intellectual property system.

The work is justified by discussing and illustrating the importance of planning public policies for innovation and intellectual property as an alternative for the advancement and consolidation of developing economies, such as Brazil. Based on the results of this study, it will be possible to understand the case of Brazil, in general, and identify important aspects that can be implemented for the organization of an

[1] Future works may consider the country's main economic sector, through which it is part of international trade, for an analysis on the use of intellectual property systems.

[2] Future works may analyze the origin of capital in the main sectors of the economy, aiming to elucidate the reasons why there is a small volume of patents granted to residents in countries such as Brazil.

innovation and intellectual property system.

2. Research Methodology

Initially, some Brazilian ST&I indicators will be presented. Subsequently, a conceptual framework will be presented with suggestions for planning and organizing an innovation and intellectual property system in developing countries.

The research consists of a study of the Brazilian case with an essentially descriptive approach (Cooper & Schindler, 2016). Next, the bases used for surveying the indicators are presented.

2.1 Bases consulted and surveyed indicators

To conduct the study, ST&I indicators were collected from the sources indicated in Figure 1:

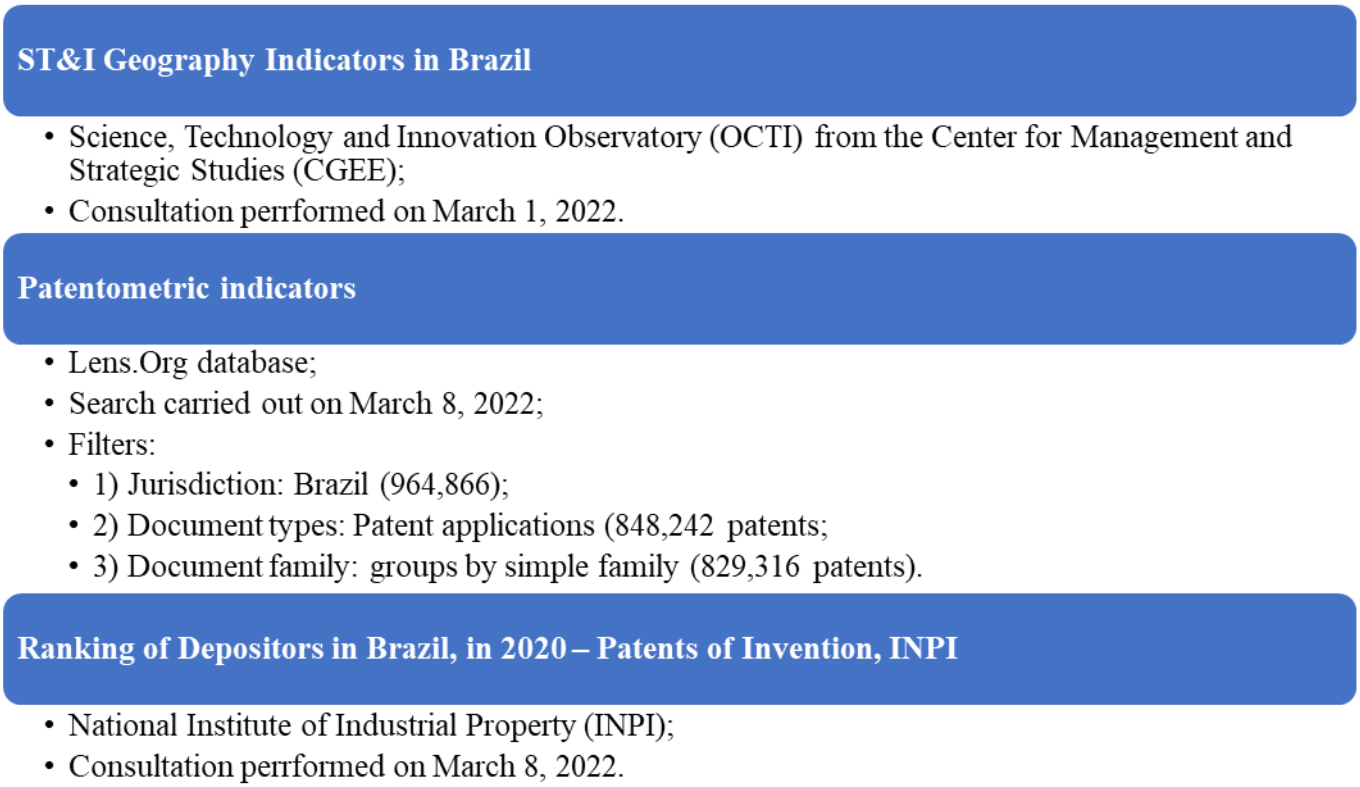

Figure 1. ST&I indicators surveyed for the Brazilian case study

- Indicators of ST&I Geography in Brazil, from the Science, Technology and Innovation Observatory (OCTI), from the Center for Management and Strategic Studies (CGEE): the OCTI observatory was created to monitor scientific, technological and innovation production in Brazil. The indicators of the Geography of ST&I, specifically, present information on the country and its regions or states, for the evaluation of the potentials and bottlenecks of Brazilian regions with regard to ST&I. Altogether, 18 indicators of ST&I processes are presented, distributed in 10 dimensions (expenditure by state governments on Research and Development (R&D), financing, expenditure by business entities on innovative activities, Human Resources (HR) in ST&I: training of masters and PhDs, cooperation

networks, bibliographic and technological production, innovation in companies, employment of masters and PhDs, growth of micro-establishments and foreign trade) and in 04 natures (inputs, processes, results and impacts) (OCTI, 2022). The OCTI website is https://octi.cgee.org.br.

- Lens.Org patentometric indicators: The Lens.Org database presents global patent data, enabling the mapping of innovation worldwide (Lens.Org, 2022). For the present work, patents in Brazil were analyzed, especially in relation to temporal evolution and the main applicants. The base website is https://www.lens.org/. It is important to note that Lens.Org presents considerable variation in company names, and a given term may not capture all the patents of that organization.
- Ranking of Resident Applicants of Patents for Invention in 2020, from INPI: the National Institute of Intellectual Property is the Brazilian body responsible for the protection of industrial property assets, such as patents, trademarks, among others. In recent years, the institution has been carrying out a series of studies on the panorama of intellectual property in Brazil, forming a kind of observatory. For the present study, the Ranking of Resident Applicants of Patents for Invention in the year 2020 was used, which can be accessed from the Statistics and Economic Studies menu (INPI, 2021). The INPI website is https://www.gov.br/inpi/pt-br.

Access to the databases took place between March 01 and 08, 2022. Based on the findings of the Brazilian case and considering the established discussion, a framework was proposed that can be applied in the economies of developing countries.

The suggested arrangements aim to optimize the innovation and intellectual property system of developing countries, since, for the better engagement of these economies in relation to innovation, a set of strategic actions regarding the actors of the system is necessary (State, institutions and companies), their partnerships, the financing of innovative activities and the organization of the dynamics of protecting the assets resulting from the innovation process.

3. Results Analysis

The analysis of the Brazilian context of Science, Technology and Innovation makes it possible to identify that, despite several strategic elements related to these resources, the country needs considerable advances for better development.

Below, Table 1 presents the indicators of the Geography of ST&I in Brazil.

Table 1. Indicators of the Geography of ST&I in Brazil

Nature	Dimension	Indicator	Indicator Amplitude		Brazil
			Minimum value	Maximum value	
Input	Financing	BNDES financing aimed at innovation	0	100%	100%
	Human Resources in ST&I: training of masters and PhDs	Master's degrees per 100,000 inhabitants	6.6	61.1	29.8
		Doctoral degrees per 100,000	0.7	21.1	10.4

		inhabitants			
	Expenditure by business entities in innovative activities	Expenditure on internal activities and external R&D acquisition	0.13%	2.31%	0.75%
		Expenditure on other innovative activities	0.18%	2.26%	0.9%
		Technical-Scientific Personnel in business entities by groups of one thousand employees	1.94	16.66	10.58
	State government expenditures on R&D	State government expenditure on R&D in relation to total revenues	0.01%	4.89%	1.63%
Process	Cooperation networks	Innovation Cooperation Rate	1.8%	27.95%	14.93%
		CNPq scholarships linked to companies, in relation to the total value of these scholarships in Brazil	0	100%	100%
		CNPq scholarships linked to companies, in relation to the total number of CNPq scholarships in the state	0.06%	25.75%	2.26%
Result	Bibliographic and technological production	Patents per hundred thousand inhabitants	0.4	4.45	2.64
		Bibliographic production of teachers and students linked to PPG	1.63	2.82	2.33
Impact	Employment of masters and PhDs	Masters and PhDs per thousand employees in the manufacturing industry	0	0.86	0.37
		Masters and PhDs per thousand employees in services of greater knowledge intensity	0.21	4.59	1.24
	Growth of micro-establishments	Micro-enterprise growth-development and licensing of computer programs	-11.23%	37.61%	5.6%
		Growth of micro-establishments-IT services and provision of information services	-16.98%	9.99%	-1.37%
	Innovation in companies	Innovation rate in companies	19.54%	45.97%	33.88%
	Foreign trade	Exports of goods, by sectors of high and medium high technological intensity	0	44.47%	21.11%

Note: BNDES – National Bank for Economic and Social Development; ST&I – Science, Technology and Innovation; R&D – Research and Development; CNPq – National Council for Scientific and Technological Development; PPG – Graduate Programs; IT – Innovation Technology.
Source: adapted from the Science, Technology and Innovation Observatory/CGEE (2022).

With regard to the "inputs" of the ST&I process, the country presents a good result in the indicator "financing carried out by the National Bank for Economic and Social Development (BNDES) for innovation activity", an indicator that achieves 100% performance, in a range from 0 to 100%. In relation to the other indicators, referring to human resources in Science, Technology and Innovation (ST&I) (masters and PhDs), as well as expenditures for R&D or innovative activities, both by the government and by companies, a median performance is observed.

Regarding the nature of the "process," the indicator "Scholarships from the National Council for Scientific and Technological Development (CNPq) with links to companies, in relation to the total value of these grants in Brazil" presents a good performance, reaching 100%. However, when the rates of cooperation for innovation or the indicator of CNPq grants with links to companies are analyzed, also related to cooperation, considering the total number of grants of the institution in the states, it is observed that the country does not obtain an outstanding result.

When analyzing the indicators inherent to the "results" of ST&I, Brazil presents an average result in terms of technological and bibliographic production. Even so, it is important to emphasize that bibliographic production has achieved better results than technological production.

When the impacts of the ST&I process are analyzed, there is also a median positioning of the country in the dimensions of employment of masters and PhDs, growth of micro-establishments, innovation in companies and foreign trade (exports). Thus, it is clear that, even with the national potential (technical, natural, cultural, among others), Brazil generates impacts below expectations, and must re-articulate its innovation system.

In the 2000s, the State adopted a more developmental strategic approach. Thus, BNDES operations expanded significantly, reinforcing its role in infrastructure financing, in supporting Brazilian global actors aimed at increasing industrial competitiveness, in innovation policies and in supporting small and medium-sized companies (Palludeto & Borghi, 2020).

Thus, from the performance of this actor (BNDES), the importance of the strategic planning of the other players in the innovation system is noted, focusing on strengthening and leading their actions. In addition, the integrated and coordinated action of all the components of the system is also important, since the alignment between the various institutions tends to strengthen and dynamize it.

In order to broaden the discussion on the results of innovation in the country, especially in the patenting activity, other important indicators are presented below. Thus, Figure 2 presents the evolution of the number of publications of patent applications in Brazil.

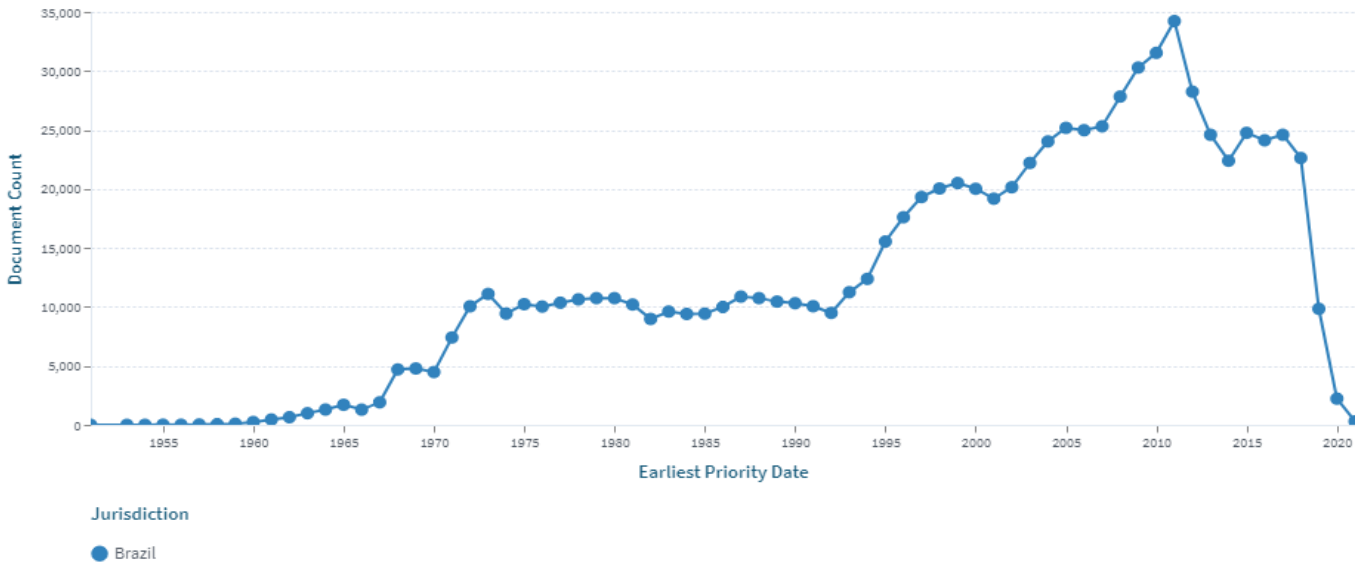

Figure 2. Evolution of the number of patent applications filings in Brazil

Note: The drop in the number of applications at the end of the interval can be explained by the secrecy period of the patenting process, which lasts 18 months. Thus, it was disregarded for the purposes of this analysis.

Source: Lens.Org (2022).

Figure 2 shows the growth in the number of patent applications filed from the 1990s onwards. It is noteworthy that the volume of applications started to increase mainly after the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) and of the process of regulating the intellectual property system in the country, with the regulation of the sector. In this regard, the Industrial Property Law (BRASIL, 1996), the Innovation Law (BRASIL, 2004), the research incentive law known as "Lei do Bem" (Good Law) (BRASIL, 2005), the New Legal Framework for Innovation in Brazil, Law no. 13,243/2016 (BRASIL, 2016), Decree No. 9,283/2018 (BRASIL, 2018), among other regulations[3].

However, it is important to highlight that, as of the 2010s, there was a considerable reduction in the number of applications made. This aspect may be related to the drop in resources for financing and fostering innovation activity in the country in recent years.

In Brazil, there was an important attempt to stabilize and predict resources for financing and promoting Science and Technology (S&T), through sectoral funds that became part of the National Fund for Scientific and Technological Development (FNDCT), at the end of the 1990s. However, while the collection of sectoral funds grew, the government reduced the baseline budget of the Ministry of Science and Technology and, thus, even with the growth of the absolute budget, the participation of that Ministry in the total budget of the federal government remained stable. On the other hand, the shares of oil royalties that fed the Funds became their main source. When the Petroleum Law was passed (BRASIL, 2013), the resources that were previously destined to the Sectoral Petroleum Fund, being the largest part of the Sectoral Funds, started to be directed to education and health, an aspect that generated a huge loss for Brazilian Science and

[3] Other examples of regulations that regulate the intellectual property and innovation system in Brazil are the Cultivars Law (BRASIL, 1997), the Copyright Law (BRASIL, 1998b), the Computer Programs Act (BRASIL, 1998a) and the Law of Topographies of Integrated Circuits (BRASIL, 2007).

Technology (De Negri, 2018).

Another important aspect of innovative activity in Brazil is related to the main patent applicants. Table 2, below, shows the main patent applicants in the country over the years.

Table 2. Main patent applicants in Brazil

No.	Applicants	No. of applications
1	Qualcomm Inc	6,813
2	Procter & Gamble	5,291
3	Bayer Ag	4,815
4	Unilever Nv	4,601
5	Gen Electric	4,097
6	Du Pont	3,703
7	Siemens Ag	3,511
8	Basf Se	3,225
9	Bosch Gmbh Robert	2,971
10	Shell Int Research	2,901

Source: Lens.Org (2022).

The largest patent applicants in the country are multinational and non-resident companies, originating in other countries. The Brazilian company and resident that has the most patent applications, currently, is PETROBRAS, with the amount of 1,319 applications for patents, occupying the 41st position in the ranking. Among the reasons for this national panorama, especially regarding the performance of Brazilian companies in patent protection, these organizations may be interested only in the national market, lack of knowledge about the intellectual property system, lack of financial and human resources to carry out the protections, small presence of researchers in companies, small R&D expenses by Brazilian companies, time required to obtain a patent in Brazil, due to limitations in the number of INPI examiners, among others (Cota et al., 2016).

In addition, according to Chiarini et al. (2019), this result shows the interest of companies from developed countries in constituting a reserve for emerging markets, such as Brazil. Also, it is an important indication that national companies may not focus their main strategies on the patenting process. Furthermore, the patents of non-residents do not reflect the national inventive capacity and also tend to be unrelated to the country's innovative capacity.

Finally, the analysis of the main resident applicants of invention patents at the INPI, in the year 2020, reveals another important finding, as shown in Table 3.

Table 3. Ranking of resident applicants of invention patents at INPI in 2020

No.	Resident applicants	No. of applications
1	Federal University of Campina Grande (UFCG)	96
2	Petróleo Brasileiro SA (PETROBRAS)	79
3	Federal University of Paraiba (UFPB)	74
4	Federal University of Minas Gerais (UFMG)	63
5	Júlio de Mesquita Filho State University of São Paulo (UNESP)	55
6	Federal University of Pernambuco (UFPE)	55
7	University of Sao Paulo (USP)	51
8	State University of Campinas (UNICAMP)	50
9	Federal University of Pelotas (UFPel)	38
10	Federal University of Uberlândia (UFU)	38
11	Federal University of Paraná (UFPR)	38

Source: INPI, Advisory on Economic Affairs (2022).

Considering only residents, it is noted that in Brazil, universities are the main applicants of invention patents. This aspect is directly related to the innovation model adopted by the country, in which postgraduate personnel with master's and doctoral degrees are predominantly inserted in university institutions, especially public ones.

In addition, this national profile may be linked to federal public policies implemented in Brazil, with legal support and incentives for the commercialization of results from scientific and technological research carried out in universities. The Innovation Law, for example, regulates the management of intellectual property, technology transfers and encourages the creation of Technological Innovation Centers (NIT) in these institutions (Chiarini et al., 2019).

Therefore, it is important that a process of university-company approximation occur in a more intense way, uniting the technical expertise of Brazilian universities in the development of research and technological innovations to the productive process, in organizations, adding value at the national level. Also relevant is the repositioning of national companies with regard to investment in research, development and innovation and the use of intellectual property to protect their technological assets.

Most technological knowledge is produced through mature innovation systems, generally implemented in developed countries, which pay more for the use of intellectual property and are also better rewarded for the investments made. Furthermore, in the case of immature innovative systems, when the country has little local innovative capacity, the strategy of strengthening intellectual property rights does not necessarily stimulate technological innovation (Chiarini et al., 2017; Chiarini & Silva, 2016). It is noteworthy, in this case, that protection through intellectual property tends to even restrict copying and reverse engineering, which can contribute as sources of learning and development of immature innovation systems (Lall, 2003).

Developing countries tend to have unfavorable environments for patenting activity, due to their weaker legal environments and which do not provide legal institutional protection to companies in the field of innovation, the high costs of protection and the long processes of patent applications, which sometimes outweigh the benefits of patenting. Government programs that encourage patenting without a focus on

performance, as well as weaker technological and innovation capabilities in developing countries also hamper patenting strategies (Paula & Rocha, 2020).

A study on Sudan identified that factors that hamper the protection of intellectual property in the country are low integration with international institutions, lack of legal issues, lack of government concern, lack of private sector concern, weak institutions, lack of public awareness, lack of resources, lack of an intellectual property culture, high costs of innovation, lack of cooperation between universities and industry and lack of strategic coordination in the area. Consequently, the country has a deficient innovation system, preventing direct foreign investment and technology transfer (Nour, 2015).

Furthermore, Nour (2015) indicates that part of the actions that can strengthen an intellectual property policy involve the promotion of adequate legislation for the implementation of intellectual property rights; planning and commitment to international intellectual property rights (IPR) agreements; finance, investments and resources applied in the area; implementation of social partnerships to encourage the protection of IPR, linked to the concern and attention of the government, the private sector and society; incentives for cooperation between universities and industries, in favor of technological innovation; the coordination and culture of institutions, in favor of IPR protection.

In addition, intellectual property policies need to be customized by the type and size of companies present in the country. Strong intellectual property rights are beneficial for R&D-intensive companies and industries, while they can be harmful to small and medium-sized companies, which have limited resources. Thus, it is important to consider the types of companies, their segments, as well as the capacity for innovation, the level of globalization, size of the domestic market, market structure, in addition to the stage of the national innovation system (Cho et al., 2015). In the case of small and micro companies, for example, when patent ownership is shared (co-patents), there is a tendency to attract external financial support, reducing the impact of size and improving business valuation capacity (Diwei Lv et al., 2018).

It is also important to highlight that the capacity for innovation depends on the possibility of attracting resources to explore innovative knowledge. Thus, access to resources such as skilled labor and capital resources is a function of public policies and the country's regulatory environment. In addition, an environment must also be created that facilitates the commercialization of new ideas and technologies (Colombo & Shafi, 2016). Finally, a clear and accurate legal environment can contribute to the intellectual property system (Ren & Duprez, 2019) and, consequently, to the country's innovation policy.

4. Framework Proposition

Considering the present discussion and the findings of this study regarding the Brazilian case, a country with a developing economy, suggestive actions are proposed below for the elaboration and planning of an integrated strategy for intellectual property and innovation. The group composed of strategic actions, system actors and their relationships was called “Suggestive conceptual framework for the planning and organization of innovation and intellectual property systems in developing countries”, as shown in Figures 3 and 4.

Initially, Figure 3 presents the actors of the proposed system, as well as their respective functions, namely:

- Regulatory Function: State;

- Coordination Function: Strategy Coordination;
- Protection Function: Intellectual Property Protection Bodies;
- Promotion Function: Promotion Organs and External Funders;
- Function of Production and Operationalization of Knowledge: Industries and Small and Medium Enterprises (SMEs) and Institutes of Science and Technology (IST).

The importance of integrated action by these players is highlighted, based on their respective roles.

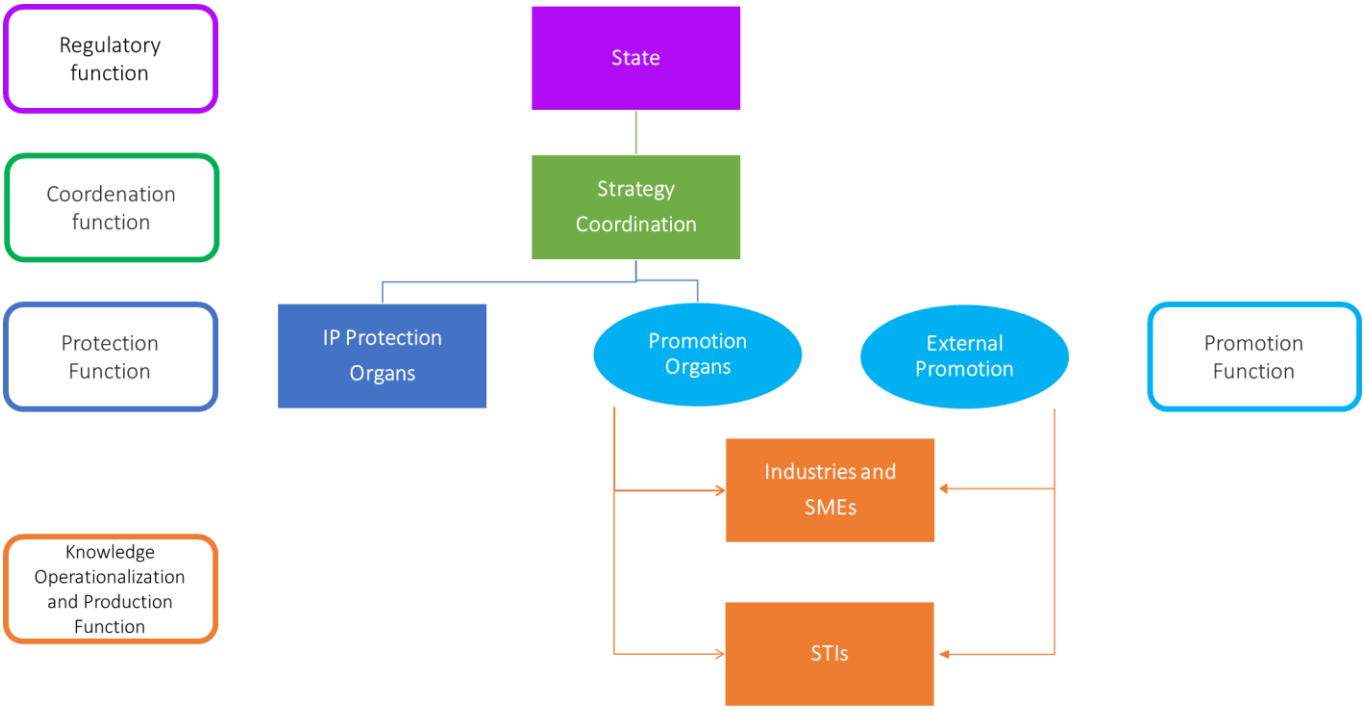

Figure 3. Actors of the suggestive conceptual framework for the planning and organization of innovation and intellectual property systems in developing countries

Note: IP – Intellectual Property; SMEs – Small and Medium Enterprises; IST – Institutes of Science and Technology.

Then, in Figure 4, a table with the definition of actions for each actor of the proposed system is presented. It is important to note that these actions are based on the strategies listed below:

- Consider the knowledge economy, social issues, technological trends and competitiveness as guiding elements of innovation and intellectual property policies;
- Position the State as the main articulator of the necessary structure for the functioning of the innovation system, considering: the strengthening of innovation and intellectual property legislation for the benefit of the country's development, the financing of R&D, the establishment of an adequate environment for commercialization of technologies, among others;
- Establish the General Coordination of the innovation strategy, responsible for articulating and directing the main strategic actions;
- Strengthen intellectual property protection bodies, by expanding the number of examiners, prioritizing the protection of national technologies, especially those from University-Company partnerships, disseminating knowledge on intellectual property, among others;

- Develop a personalized innovation strategy for industries and SMEs, considering the specifics of each segment (sector) and business size;
- Strengthen strategies to encourage innovation and entrepreneurship, considering the multiple actors in the system and the stages of ongoing and potential innovative activities;
- Expand the promotion of University-Company partnerships, aiming at technological development, the exchange of researchers and technological transfers; in addition, customizing the support according to the type of institution served (IST, industry or SME);
- Strengthen the role of ISTs in technological development, in the training of manpower focused on the knowledge economy and in the dissemination of intellectual property among researchers in the country. In addition, insert the theme of intellectual property protection in management and technology courses and instigate mechanisms aimed at the development of an entrepreneurial culture, with the implementation of incubators, spin-offs, among others;
- Expand the possibility of external R&D funding, both in ISTs and in industries and SMEs;
- Work in international partnerships aimed at technological development and training of researchers;
- Articulate the evaluation of results originating from the promotion strategies (state bodies).

Other recommendations can be identified and better understood from Figure 4.

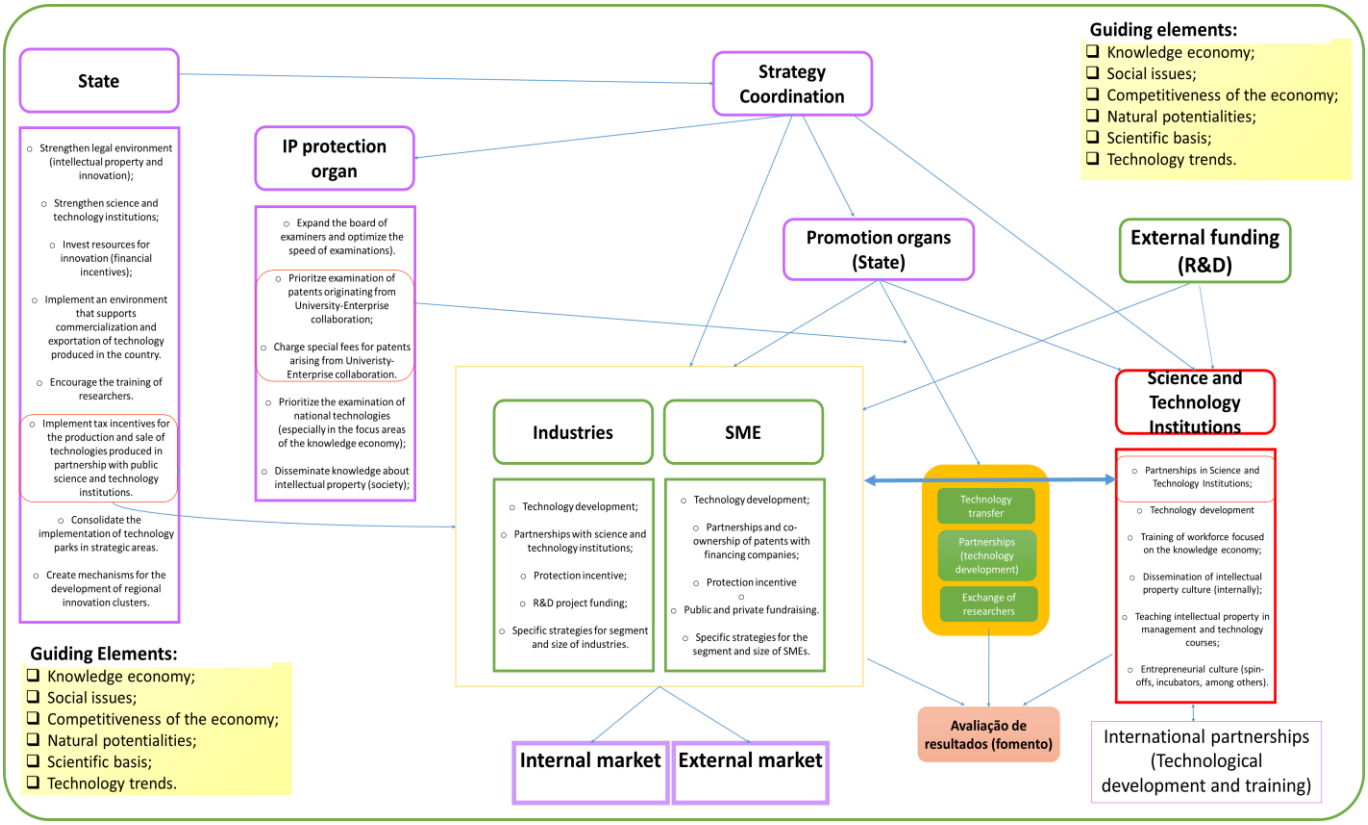

Figure 4. Suggestive conceptual framework for planning and organizing innovation and intellectual property systems in developing countries

5. Considerations

The present work, initially, analyzed the panorama of Science, Technology and Innovation in Brazil, through indicators. Then, it proposed a framework with important actions for the planning and organization of the innovation and intellectual property system of a country with a developing economy.

Initially, the indicators of ST&I Geography in Brazil were verified. It was observed that the country has medium indices, failing to achieve superior performance in the absolute majority of indices that analyze the inputs, processes, results and impacts of the process. Therefore, it is important to reinforce the necessary planning of the ST&I system, aiming at a more efficient dynamic, culminating in technological production and value generation.

On the other hand, when analyzing patentometric indicators, some observations are important: the TRIPS Agreement and the regulation of the intellectual property and innovation system were crucial for the expansion of patent protection applications in Brazil. However, as the resources for funding science and technology reduced, starting in the 2010s, there was also a significant decrease in the number of application documents annually. This aspect suggests the relevance of the ST&I financing strategy for national technological production. In addition, it is also important to plan for a better diversity of forms of investment in ST&I, as in the North American case (De Negri, 2018).

Then, the largest patent applicants in Brazil were analyzed over the years, as well as the largest resident applicants of invention patents in the year 2020. In the first case, it was observed that multinational, non-resident organizations prevail, to the detriment of national companies.

In the second case, it was identified that universities were the largest resident applicants of the year 2020, and not business organizations or industries. Such aspects explain the need for better engagement of national companies with the intellectual property system, aiming at exploiting its results in technological innovation and its benefits. In addition, a more efficient organization of university-company partnerships in the country is beneficial, uniting the technical expertise of universities in the development of research and technological innovations to the productive process in organizations.

Finally, the “Suggestive conceptual framework for the planning and organization of innovation and intellectual property systems in developing countries” was proposed. The model presents a series of suggestive actions for the innovation and intellectual property system, based on the functions of its main actors: Regulatory Function (State), Coordination Function (Strategy Coordination), Protection Function (Protection Agency of Intellectual Property), Promotion Function (Development Organs and External Funders) and Knowledge Production and Operationalization Function (Industry, SMEs and ISTs).

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7. References

Agostini, L., Filippini, R., & Nosella, A. (2016). Protecting intellectual property to enhance firm performance: Does it work for SMEs. *Knowledge Management Research and Practice*, *14*(1), 96–105.

BRASIL. (1996). *Lei nº 9.279, de 14 de maio de 1996. Regula direitos e obrigações relativos à propriedade industrial*. http://www.planalto.gov.br/ccivil_03/Leis/L9279.htm

BRASIL. (1997). *Lei nº 9.456, de 25 de abril de 1997. Institui a Lei de Proteção de Cultivares e dá outras providências*. http://www.planalto.gov.br/ccivil_03/LEIS/L9456.htm

BRASIL. (1998a). *Lei nº 9.609, de 19 de fevereiro de 1998. Dispõe sobre a proteção da propriedade intelectual de programa de computador, sua comercialização no País, e dá outras providências*. http://www.planalto.gov.br/ccivil_03/leis/L9609.htm

BRASIL. (1998b). *Lei nº 9.610, de 19 de fevereiro de 1998. Altera, atualiza e consolida a legislação sobre direitos autorais e dá outras providências*. http://www.planalto.gov.br/ccivil_03/leis/l9610.htm

BRASIL. (2004). *Lei nº 10.973, de 2 de dezembro de 2004. Dispõe sobre incentivos à inovação e à pesquisa científica e tecnológica no ambiente produtivo e dá outras providências*. http://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2004/Lei/L10.973.htm

BRASIL. (2005). *Lei n° 11.196. Institui o Regime Especial de Tributação para a Plataforma de Exportação de Serviços de Tecnologia da Informação - REPES, o Regime Especial de Aquisição de Bens de Capital para Empresas Exportadoras - RECAP e o Programa de Inclusão Digital; dispõe sobre incentivos fiscais para a inovação tecnológica; altera o Decreto-Lei nº 288, de 28 de fevereiro de 1967, o Decreto nº 70.235, de 6 de março de 1972, o Decreto-Lei nº 2.287, de 23 de julho de 1986, as Leis nºs 4.502, de 30 de novembro de 1964, 8.212, de 24 de julho de 1991, 8.245, de 18 de outubro de 1991, 8.387, de 30 de dezembro de 1991, 8.666, de 21 de junho de 1993, 8.981, de 20 de janeiro de 1995, 8.987, de 13 de fevereiro de 1995, 8.989, de 24 de fevereiro de 1995, 9.249, de 26 de dezembro de 1995, 9.250, de 26 de dezembro de 1995, 9.311, de 24 de outubro de 1996, 9.317, de 5 de dezembro de 1996, 9.430, de 27 de dezembro de 1996, 9.718, de 27 de novembro de 1998, 10.336, de 19 de dezembro de 2001, 10.438, de 26 de abril de 2002, 10.485, de 3 de julho de 2002, 10.637, de 30 de dezembro de 2002, 10.755, de 3 de novembro de 2003, 10.833, de 29 de dezembro de 2003, 10.865, de 30 de abril de 2004, 10.925, de 23 de julho de 2004, 10.931, de 2 de agosto de 2004, 11.033, de 21 de dezembro de 2004, 11.051, de 29 de dezembro de 2004, 11.053, de 29 de dezembro de 2004, 11.101, de 9 de fevereiro de 2005, 11.128, de 28 de junho de 2005, e a Medida Provisória nº 2.199-14, de 24 de agosto de 2001; revoga a Lei nº 8.661, de 2 de junho de 1993, e dispositivos das Leis nºs 8.668, de 25 de junho de 1993, 8.981, de 20 de janeiro de 1995, 10.637, de 30 de dezembro de 2002, 10.755, de 3 de novembro de 2003, 10.865, de 30 de abril de 2004, 10.931, de 2 de agosto de 2004, e da Medida Provisória nº 2.158-35, de 24 de agosto de 2001; e dá outras providências*. http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2005/lei/l11196.htm

BRASIL. (2007). *Lei n° 11.484, de 31 de maio de 2007. Dispõe sobre os incentivos às indústrias de equipamentos para TV Digital e de componentes eletrônicos semicondutores e sobre a proteção à propriedade intelectual das topografias de circuitos integrados, instituindo o Programa de Apoio ao Desenvolvimento Tecnológico da Indústria de Semicondutores – PADIS e o Programa de Apoio ao*

Desenvolvimento Tecnológico da Indústria de Equipamentos para a TV Digital – PATVD; altera a Lei no 8.666, de 21 de junho de 1993; e revoga o art. 26 da Lei no 11.196, de 21 de novembro de 2005. http://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2007/Lei/L11484.htm

BRASIL. (2013). *Lei nº 12.858, de 9 de setembro de 2013. Dispõe sobre a destinação para as áreas de educação e saúde de parcela da participação no resultado ou da compensação financeira pela exploração de petróleo e gás natural, com a finalidade de cumprimento da meta prevista no inciso VI do caput do art. 214 e no art. 196 da Constituição Federal; altera a Lei nº 7.990, de 28 de dezembro de 1989; e dá outras providências*. http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2013/lei/l12858.htm

BRASIL. (2016). *Lei nº 13.243, de 11 de janeiro de 2016. Dispõe sobre estímulos ao desenvolvimento científico, à pesquisa, à capacitação científica e tecnológica e à inovação e altera a Lei no 10.973, de 2 de dezembro de 2004, a Lei no 6.815, de 19 de agosto de 1980, a Lei no 8.666, de 21 de junho de 1993, a Lei no 12.462, de 4 de agosto de 2011, a Lei no 8.745, de 9 de dezembro de 1993, a Lei no 8.958, de 20 de dezembro de 1994, a Lei no 8.010, de 29 de março de 1990, a Lei no 8.032, de 12 de abril de 1990, e a Lei no 12.772, de 28 de dezembro de 2012, nos termos da Emenda Constitucional no 85, de 26 de fevereiro de 2015*. http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2016/Lei/L13243.htm

BRASIL. (2018). *Decreto nº 9.283, de 7 de fevereiro de 2018. Regulamenta a Lei nº 10.973, de 2 de dezembro de 2004, a Lei nº 13.243, de 11 de janeiro de 2016, o art. 24, § 3º, e o art. 32, § 7º, da Lei nº 8.666, de 21 de junho de 1993, o art. 1º da Lei nº 8.010, de 29 de março de 1990, e o art. 2º, caput, inciso I, alínea "g", da Lei nº 8.032, de 12 de abril de 1990, e altera o Decreto nº 6.759, de 5 de fevereiro de 2009, para estabelecer medidas de incentivo à inovação e à pesquisa científica e tecnológica no ambiente produtivo, com vistas à capacitação tecnológica, ao alcance da autonomia tecnológica e ao desenvolvimento do sistema produtivo nacional e regional*. http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/decreto/d9283.htm

Cavalheiro, G. M. do C., & Brandao, M. (2017). Assessing the IP portfolio of industrial clusters: the case of the Brazilian footwear industry. *International Journal of Manufacturing Technology and Management*, *28*(8), 994–1010.

Chiarini, T., Caliari, T., Rapini, M. S., & Ribeiro, L. C. (2019). A evolução do patenteamento no Brasil: análise dos domínios tecnológicos "química" e "engenharia elétrica." In T. Chiarini & T. Caliari (Eds.), *A economia política na América Latina: Tecnologia e Inovação a favor do desenvolvimento/Organização* (pp. 241–272.). Paco.

Chiarini, T., Rapini, M. S., & Silva, L. A. (2017). Access to knowledge and catch-up: Exploring some intellectual property rights data from Brazil and South Korea. *Science & Public Policy*, *44*(1), 95–110.

Chiarini, T., & Silva, A. L. G. da. (2016). Intellectual property rights and innovation system: some lessons from Brazil. *International Journal of Innovation and Learning*, *20*(3), 265–288.

Cho, K., Kim, C., & Shin, J. (2015). Differential effects of intellectual property rights on innovation and economic performance: A cross-industry investigation. *Science & Public Policy*, *42*(6), 827–840.

Colombo, M. G., & Shafi, K. (2016). The impact of patenting on the size of high-tech firms: the role of venture capital and product market regulation. *Economia E Politica Industriale*, *43*(1), 85–103.

Cooper, D. R., & Schindler, P. S. (2016). *Métodos de Pesquisa em Administração* (Scientific Linguagem Ltda, trans.; 12th ed.). AMGH.

Cota, M. M. G., de Paula Silva Gomes, J., Lunardi, L. M., de Andrade Gomes, C., Salles, A. M., Di Blasi, G., & Soares, E. E. (2016). Patent Policies and Intellectual Property Challenges in Brazil. *Industrial Biotechnology* , *12*(1), 58–61.

De Negri, F. (2018). *Novos caminhos para a inovação no Brasil*. Wilson Center.

Diwei Lv, D., Zeng, P., & Lan, H. (2018). Co-patent, financing constraints, and innovation in SMEs: An empirical analysis using market value panel data of listed firms. *Journal of Engineering and Technology Management*, *48*, 15–27.

INPI. (2021). *Ranking Depositantes Residentes - 2020*. https://www.gov.br/inpi/pt-br/central-de-conteudo/estatisticas/arquivos/estatisticas-preliminares/rankdepositantesresidentes-2020.pdf

Lall, S. (2003). Indicators of the relative importance of IPRs in developing countries. *Research Policy*, *32*(9), 1657–1680.

Lens.Org. (2022). *The Lens - Free & Open Patent and Scholarly Search*. Lens.Org. https://www.lens.org/

Nour, S. S. O. M. (2015). The economic importance and impacts of intellectual property rights (IPRs) in Sudan. *African Journal of Science, Technology, Innovation and Development*, *7*(2), 126–143.

OCTI. (2022). *OCTI - Observatório de Ciência, Tecnologia e Inovação*. https://octi.cgee.org.br/indicadores/brasil

ONU. Economic and Social Council. (2021). *Progress towards the Sustainable Development Goals: Report of the Secretary-General*. https://unstats.un.org/sdgs/files/report/2021/secretary-general-sdg-report-2021--EN.pdf

Palludeto, A. W. A., & Borghi, R. A. Z. (2020). Institutions and Development From a Historical Perspective: the Case of the Brazilian Development Bank. *Review of Political Economy*, *1*, 1–19.

Paula, F. de O., & Rocha, R. J. S. (2020). The Effect of R&D Investments and Patents on the Financial Performance of Latin American Firms. *Latin American Business Review*, *27*, 1–20.

Ren, X., & Duprez, R. (2019). Financial impact of legal practice on software patent subject matter eligibility: Effectiveness of a workable standard. *The Journal of High Technology Management Research*, *30*(1), 50–58.

Schliessler, P. M. (2015). Patent litigation and firm performance: The role of the enforcement system. *Industrial and Corporate Change*, *24*(2), 307–343.

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