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Santa Catarina's STI policy within the scope of federal innovation regulation: historical analysis and proposals for improvements

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PREFACE

It all started twenty-five years ago. When Fapesc emerged, the 2000s were nothing but an unclear future that inspired fear with all of the turn of the millennium symbology. The state's technology ecosystem was still incipient, development notices for this purpose from specific agencies were non-existent, and innovation was a common word only in academic circles. It was a long, winding road to get to where we are now.

Twenty-five years are not 25 days. But neither are they a mere ticking off of months on the calendar. There is a great deal of history amassed in two decades and a half. There are so many memories stored in the minds of those who walked on the same path, or of those who joined, stayed a while and then left – as in any normal walk of life.

That is how the idea for the collection you have in front of you came about – "Mapping the Development Process of the Science, Technology and Innovation Ecosystem of the state of Santa Catarina". In 2022, when we created the public notice that brought about this book, we looked back and felt the need to dive into the past and register every important item: to map the origin and historical development of the most important entities, organizations and programs, whether extinct or in effect, of the Science, Technology and Innovation (STI) ecosystem in Santa Catarina.

In 25 books we show how the history of the ecosystem merges with the appearance and strengthening of its embryo, the Santa Catarina Foundation for Research and Innovation, or Fapesc. And also how it associated with scientific, technological and innovation centers, such as the Sapiens Parque and the ParqTec Alfa; innovation hubs; business incubators; centers for innovation; and STI laboratories, all of which opened paths to what today is known as the Santa Catarina Technology Network. And how all of this grew until it became the Santa Catarina Technology Association (Acate) and, later, appeared as the Pact for Innovation.

We recovered every aspect regarding contributions that the ecosystem received from other departments, such as the Acafe System, Sebrae, the Certi Foundation, Facisc, Fiesc and business organizations. And how the ecosystem also went in the opposite direction, making a direct impact on the daily lives of universities, institutes and public agencies, as well as on the industry of Santa Catarina.

This book also shows how the ecosystem made national and international connections, how we evolved with the passing years, and how this led to the Pact for Innovation, to Intellectual Property assets and to the consolidation of the state of Santa Catarina as a reference in STI.

This collection, a treasure for our state, gives us a complete panorama of where we came from and how we got to where we are. Challenges, weaknesses and the needs of several different ecosystem agents, departments and organizations are identified to help us move forward.

Hope you enjoy reading it!

Fábio Wagner Pinto
Fapesc President

PRESENTATION

On the occasion of the festivities alluding to the twenty-five years of existence, FAPESC (Santa Catarina Foundation for Research and Innovation) offers Santa Catarina society a collection of twenty-five copies dedicated to telling its story.

The "FAPESC and Its 25-Year Journey" collection is a special present in many ways.

At the same time that it recovers and crystallizes aspects and details of a successful trajectory, which makes it an invaluable source of consultation, it is built by several hands, whose craft is research, thus making it a product of plural points of view, of life experiences of people who, in one way or another, contribute to the strengthening of the science, technology and innovation ecosystem in Santa Catarina, keeping it resistant and resilient – two of the main characteristics for the dynamic balance of any ecosystem.

There is, however, another detail that makes it rare.

The Birthday Girl could have assigned the task of telling her story to duly remunerated professionals in the field.

No. Remaining faithful to the principles that made it unique, *she* preferred to base this work on isonomy and equal conditions, launching, in 2021, FAPESC Public Notice n. 24/2021, entitled Mapping of the Development Process of the Science, Technology and Innovation Ecosystem of the State of Santa Catarina, summoning researchers and actors from the science, technology and innovation ecosystem in Santa Catarina, linked to STI (Science, Technology and Innovation) Institutions, as well as non-profit private-law entities from that State, to present proposals for research and projects of a historical and bibliographic nature, whose results would generate editorial products that would contribute to the dissemination of science, the creation and improvement of public policies and to the scientific and technological development and innovation in the state of Santa Catarina.

For these reasons, it is, first and foremost, an honor to be part of this process.

The contribution of this volume meets the specific objective expressed in subparagraph "g" of item 1.2 of FAPESP public notice 24/2021: Mapping the legal framework referring to STI and outlining its relationship with the STI Ecosystem in the State of Santa Catarina. The authors set out to verify the interweaving and interpenetrations between the legal frameworks, both national and those of Santa Catarina, for STI, and to verify the legal implications of applying measures to encourage innovation and scientific and technological research within the new legal framework for science and technology in Brazil to regulating legislation in Santa Catarina. In addition to this task, with the aim of suggesting improvements to the legal reformulation of the Santa Catarina Policy on STI, the texts that make up this collection are dedicated to aspects that are especially sensitive to the area, such as the treatment of sectoral

legislation from its recent constitutionalization – which considerably alters hermeneutic interpretation criteria – the environmental, social and economic sustainability that must accompany and guide technological innovation processes, and responsibility as a legal vector to guide risk governance systems for new technologies.

The book is organized as a collection of chapters written by researchers and agents of the innovation ecosystem of the Community University of the Chapecó Region – Unochapecó and institutions and research groups from other units of the Federation, with a strong tradition in research dedicated to the subject.

Finally, we hope the results of the research presented in this joint work will be of great value to interest groups, in particular, to legislators from Santa Catarina, to formulators of policies to encourage science, technology and innovation, and to anyone interested in aspects of innovation law.

Good reading!

Reginaldo Pereira
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Summary

Introduction

In societies based on the production and application of knowledge, the ability to innovate is crucial. This conjuncture gives a specific meaning to the term technological innovation. It is no longer seen merely as a result of the inventive capacity and freedom of expression of human beings, and is now defined, in terms of the Frascati Manual by the OECD (Organization for Economic Co-operation and Development), as the set of scientific, technological, organizational, financial and commercial efforts, including investment in new knowledge, which achieve or enable the achievement of technologically new and better products and processes.

In Santa Catarina, since 1990, policies and actions to encourage science, research and innovation have passed through the Rotating Fund for the Promotion of Scientific and Technological Research of the State of Santa Catarina (FUNCITEC) and, from 1997, with the approval of State Law no. 10.355, through the Science and Technology Foundation, later designated FAPESC (the Santa Catarina Foundation for Research and Innovation), a name consolidated in 2011.

The object of the research project which resulted in this book was to produce bibliographic material to integrate a set of publications that deal with the development process of the Santa Catarina Ecosystem of Science, Technology and Innovation (STI), focusing on the last 25 years.

To this end, it proposed to map, from a historical perspective, the Federal and State legal frameworks, referring to the STI built in the last decades, and to outline the contours of the implications arising from changes made by Constitutional Amendment n. 85/2015 to federal legislation on state legislation and the set of infralegal norms that integrate and guide the STI Ecosystem of Santa Catarina, from a legal point of view.

The research was carried out through a bibliographic survey of a historical nature and analyses and comparisons between the federal and Santa Catarina legislation dedicated to the subject. The research results are part of three books: two written in the national vernacular – one printed and the other in e-book format – and a third, in English, available in digital format.

The justification for the proposal resides in the importance of drawing parallels between the federal and state legislative production of the last decades that allow us to understand the relevance of the legal architecture that is adequate for the full development of the STI Ecosystem of Santa Catarina. All this in a scenario marked by the need to adapt its legislation to the provisions of the applied federal law without, however, losing the ability to “innovate” in proposals that meet the peculiarities of Santa Catarina.

In the socioeconomic aspect, the proposal is justified by the strategic importance that science, technology and innovation hold.

There are no major doubts regarding the centrality that technological development has acquired in today's societies. Nations seek to promote social progress through economic progress, which largely depends on the strength of the scientific community.

The changes promoted by Law no. 13.243/16 aim to streamline technology transfer processes and enhance basic research so that results can be transferred to the productive sector and, therefore, generate economic and social gains.

The correct understanding of measures to encourage innovation and scientific and technological research and the instruments to support R&D (research and development) processes included in the legal framework for science and technology in Brazil is an essential condition for the legislator's will to be implemented.

In addition, the research raised subsidies for the state of Santa Catarina to promote the adjustment of its legal framework of science, technology and innovation to the general rules of the new Brazilian legal framework, thereby avoiding state initiatives related to the matter to incur in unconstitutionality or illegality.

On the other hand, the characteristics of the science, technology and innovation system in Santa Catarina call for in-depth studies on the impacts that the changes introduced in the constitutional and legal framework for science, technology and innovation in Brazil will cause to the Institutions related to the STI and R&D processes, and will enhance their ability to benefit from measures and instruments to encourage innovation and scientific and technological research, envisaged in federal legislation.

In short, the research is expected to provide legal certainty and qualify the action of science, technology and innovation organizations of the STI Institutions of Santa Catarina, adapting their actions to the dictates of Law n. 13.243/16.

Finally, the research is in line with Sustainable Development Goal (SDG) 9, which envisages building resilient infrastructure, inclusive and sustainable industrialization, and fostering innovation.

SDG 9 is divided into objectives to be operationalized so as to achieve the goals established therein.

SDG 9.5 aims to strengthen scientific research, improve the technological capabilities of industrial sectors in all countries, particularly in developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per million people and public and private spending on research and development.

On the other hand, SDG 9.b seeks to support national technological development, research and innovation in developing countries, even by use of guarantees of a favorable political environment for, among other things, industrial diversification.

The project research problem resulted from the overlap between justification and the theoretical review. The operation required updating the state of the art of its central theme, in the following terms.

In her doctoral thesis, Professor Carla Amado Gomes emphasizes the role of the strength of the scientific community in promoting the socioeconomic progress of countries.

The degree of development of economic policies, which enables the sustainability of the State, at the international level and, internally, the creation of conditions of material equality among citizens, with consequences for the improvement of quality of life indices, is currently directly related with the installed innovative capacity, which is defined as a series of elements of material and procedural nature that integrate product innovation, process innovation, market innovation and organizational innovation.

In the preface to the third edition of the Oslo Manual, a joint publication by the Organization for Economic Co-operation and Development (OECD) and the Statistical Office of the European Communities (EUROSTAT) that outlines guidelines for collecting and interpreting data on innovation, Nobuo Tanaka, Michel Glaude and Fred Gault point out that the generation, use and dissemination of knowledge are fundamental to economic growth, development and the well-being of nations.

The centrality acquired by innovation in the geopolitical scenario is reflected in the corporate sphere.

In economic scenarios marked by the aggregation of knowledge, the survival of an institution is directly proportional to its ability to dismantle old technologies and create more adequate solutions to the challenges posed by the new dynamics and conjunctures in which it operates.

“Creative destruction”, a term coined by the economist Joseph Schumpeter (1934) to name the continuous and dynamic process of radical or incremental innovations that introduce new products and production methods, that open new markets, that develop new sources of raw materials or that create productive chains, is one of the most significant indicators of the longevity and health of companies.

In Democratic States of Law, the adequate political ambience for the diversification of the industrial and service sectors depends, in a significant way, on a legal scenario that confers legal security – in the most diverse aspects – to the institutions that are dedicated to science, technology, innovation and distribution of knowledge.

In other words: a country’s capacity for innovation significantly depends on institutional conjunctures of science, technology and innovation and on governance scenarios that bring security to the various actors that act in processes linked to, as Klaus Schwab calls it, the Fourth Industrial Revolution.

Governance structures can be architected in a variety of ways. They range from purely governmental arrangements to legal institutes, codes of conduct, normative standards, technical standards, etc., based on self-regulation. At the moment, it is interesting to analyze the correlations between the legal structures of the Brazilian and Santa Catarina regulatory frameworks for Science, Technology and Innovation.

On January 12, 2016, the Legal Framework for Science and Technology in Brazil was amended with the publication of Law no. 13.243. The new Law promoted significant changes to the previous one (Law No. 10.973 of 2004), which dealt with measures to encourage research, innovation and scientific and technological development in the productive environment.

The main purpose of Law no. 13.243/2016 was to facilitate the approximation of companies and universities, encouraging more research, scientific and technological development and innovation in the country. In the words of the then President of the Republic Dilma Rousseff, with this law it would be possible to transform "basic science into innovation" and "[...] innovation into competitiveness, generating a new cycle of economic development."

Law no. 13.243/2016 also impacted eight other Federal Laws that are directly and indirectly related to the processes of innovation and technology transfer in Brazil:

i) Law no. 6.815/1980, which defines the legal status of foreigners in Brazil;
ii) Law no. 8.666/1993, which institutes rules for Public Administration biddings and contracts;
iii) Law no. 12.462/2012, which establishes the Differentiated Regime for Public Procurement (RDC);
iv) Law no. 8.745/1993, which provides for hiring for a fixed period to meet the temporary need of exceptional public interest;
v) Law no. 8.958/1994, which deals with relations between federal institutions of higher education and scientific and technological research and support foundations;
vi) Law no. 8.010/1990, which provides for imports of goods intended for scientific and technological research;
vii) Law no. 8.032/1990, which provides for the exemption or reduction of import taxes;
viii) Law no. 12.772/2012, which deals with the structuring of the Federal Teaching Careers and Positions Plan.

Like fifteen other states, in 2015, Santa Catarina had specific legislation on the subject, as is the case of State Law no. 14.328/2008, in effect to date, which also provides for measures to encourage scientific and technological research and innovation.

Thus, restricting the analysis to the State of Santa Catarina, we observe the incidence of two Laws – Federal Law no. 10.973/2004, with the

modifications of Law no. 13.243/2016, and State Law no. 14.328/2008 – dealing with the same matter.

It so happens that, with the approval of Constitutional Amendment no. 85/2015, science, technology, research, development and innovation joined the list of subjects subordinated to the constitutional rules that deal with the concurrent competence regime.

In such cases, the Union establishes the general norms and the States supplement the Federal Legislation, adapting it to their realities.

The fourth paragraph of article 24 of the Federal Constitution of 1988 determines that the supervenience of a Federal Law over general norms, suspends the effectiveness of the State Law, in what is contrary to it.

The verification of the provisions of the Santa Catarina Law of Science, Technology and Innovation that lost their effectiveness with the advent of Constitutional Amendment no. 85/2015 and Law no. 13.243/2016 is one of the operational issues that needed to be overcome for the general objective of this research project to be achieved.

As it was – and still is – in progress in the Legislative Assembly of the State of Santa Catarina, the Project for Constitutional Amendment no. 001/2021, which aims to adapt the text of the State Constitution to the constitutional dictates arising from Constitutional Amendment no. 85/2015, it was important to address its adequacy to the general criteria defined at the Federal level. This was not, however, the only aspect addressed.

Analyses that provided subsidies for the necessary changes in state sectoral legislation were – and still are – more than welcome from that moment on, even more so if one factor is considered: the importance of public policies and actions for the STI sector in Brazil.

In the Main Science and Technology Indicators Report, the Organization for Economic Cooperation and Development (OECD) estimates that, in its coverage area, private industry accounts for 70% of all scientific research, 10% of scientific research is conducted directly by States, while 20% of scientific research and development is carried out within universities.

The Brazilian trajectory in the fields of science, technology and, later, innovation, unlike those experienced in OECD member countries, is marked by the role of the State, whether through the creation of Universities, Institutes, Public Research Companies in various sectors of the economy, or the creation of the CNPq (National Council for Scientific and Technological Development) and State Institutions to promote and encourage STI.

In other words, the Brazilian context highlights the protagonism of public policies for science, technology and innovation which, in turn, require the construction of a legal system capable of guaranteeing

legal certainty to the agents of the Ecosystem of Science, Technology and Innovation, and of promoting the articulation between the entities that make up the Federation and that creates an environment suitable for creativity, the driving force of innovation.

In this scenario, understanding, through a historical recovery, how the Federal Union and Santa Catarina were building the legal foundations of their STI policies and systems to, based on this, problematize the noise caused by the competition of normative systems from different state entities and, mainly, the sector's potential rise from the incidence of the system of competencies defined in the Federal Constitution of 1988, has proved to be a crucial task for the construction of adequate legal frameworks.

By methodological criteria, the research was restricted to the constitutional and legal treatments of the theme, from the enactment of Constitutional Amendment no. 85/2015 and the publication, in January 2016, of the Legal Framework for Science and Technology in Brazil, which significantly amended Law no. 10.973/2004.

Law no. 13.243/16, the Legal Framework for Science, Technology and Innovation (MLCTI – Marco Legal da Ciência, Tecnologia e Inovação), was preceded by Constitutional Amendment no. 85/2015, enacted on February 26, 2015, which changed, for example, the concept of research, with innovation included at the same level as the basic science of technology. The State's duty to stimulate, train and strengthen technological science was reinforced, thus promoting the articulation between public and private entities in collaboration with the National System of Science, Technology and Innovation.

The amendment also created a constitutional basis for the Legal Framework to establish that public Scientific, Technological and Innovation (STI) Institutions may enter into agreements and contracts with private companies and public entities, these being from any of the three spheres of the federation to the provision of advisory services, research projects and the purchase and sale of products.

The Federal Constitution institutes the protection of the internal market and national companies, thus, Constitutional Amendment no. 85/2015 makes the allocation of public resources more flexible in companies, even international ones.

Constitutional Amendment no. 85/2015 altered and added provisions to the Federal Constitution in order to update the treatment of STI in Brazil. Thus, from Constitutional Amendment no. 85/2015, a legal and constitutional basis for the sanction of Law no. 13.343/16 was created, generating a new level in relation to science, technology and innovation: Brazil's Legal Framework for Science, Technology and Innovation.

This framework created the legal basis for public Scientific, Technological and Innovation (STI) Institutions to sign contracts with private companies and even with public entities of any sphere: municipal, state and federal,

as established in the sole paragraph of article 219 of CF/88 (FEDERAL CONSTITUTION OF BRAZIL, 1988).

It was expected that this opening would accelerate the development of products and services, the purchase and sale of products or advisorship, in order to stimulate the technological development of the country and the domestic market. The protection of the internal market and national companies established in CF/88 is made more flexible in favor of the allocation of public resources to any company, including foreign ones.

Article 219 A of CF/88 also allows private entities to enter into partnerships with public bodies and entities of the Brazilian State, at the federal, state and municipal levels, through a financial or non-financial counterpart.

After the enactment of the Amendment, in January 2016, Law no. 13.243 was sanctioned. The text coming from the National Congress received eleven vetoes. The positions of the Ministry of Finance (MF) and the Ministry of Planning, Budget and Management (MPOG) were decisive for the President to veto some provisions. The Ministry of Finance understood that the proposed measure of tax and social security exemption on student grants, as well as tax exemption on product imports, would result in loss of income and imbalance in social security, thus violating the Fiscal Responsibility Law (LRF). The justification for other vetoes revolved around the exemption of administration fee charging in agreements. This fact could result in legal uncertainty and increase the freedom given to STI institutions. The two Ministries declared themselves against the waiver of bidding.

The Legal Framework for Science, Technology and Innovation (MLCTI) is the result of a process of approximately five years of discussions between the National Innovation System (SNI) within the scope of the Science and Technology Commissions of the Senate Chamber. As their starting point, the changes and discussions had the recognition of necessary changes in the Innovation Law and the reduction of legal obstacles regarding nine laws related to the CTI, which, until then, were active in this system.

Among the main alterations that the New Legal Framework brought about in Law no. 10.973/04, the following stand out, by way of example: i) the authorization for the formation of strategic alliances and the development of cooperation projects involving companies, STI institutions and non-profit private entities aimed at research and development activities, which aim to the generate innovative products, processes and services and the transfer and diffusion of technology; ii) authorization for public entities to support innovation, including through the assignment of real estate and participation in the creation and management of technology parks and incubators; iii) the possibility of maintaining specific programs for micro and small companies; iv) the possibility for public entities to participate in a minority in the share capital of innovation companies, with the purpose of developing innovative

products or processes that are in accordance with the guidelines and priorities defined in the science, technology, innovation and industrial development policies of each sphere of government; v) the possibility of sharing facilities without the need for financial compensation and with any type of company; vi) the possibility of exploiting technology by STI institutions in partnership with private companies, without the former losing its status as a non-profit entity.

The law also introduced innovations in matters related to the perception by public employees of taxable income for the provision of services, prohibiting incorporation into salaries; payment of research grants to students from public and private institutions to carry out joint scientific and technological research activities; the ability of a support foundation (public or private company), registered with the MSTI, to capture, manage and apply its own revenues generated by the STI institutions and the possibility of States and Municipalities to encourage science, technology and innovation projects, through mechanisms such as subsidies, exemptions and participations, to be used in the most diverse activities.

As seen above, the innovations are countless and depend on more accurate analyses so that they are not simply copied by state and municipal legislators and public managers linked to the sector.

Approaches on some aspects of the subject make up this collection. It is divided into two parts.

The first, formed by chapters 1, 2 and 3, raises the state of the art of the research theme and discusses the links between the federal and state legal frameworks for Science, Technology and Innovation with socio-environmental sustainability and the protection of human rights.

Chapter 1, written by Felipe Migosky and Reginaldo Pereira, the former, Master in Law from the Community College of the Chapecó Region (Unochapecó) and the latter, Doctor of Law from the Federal University of Santa Catarina (UFSC) and Professor and Coordinator of the Graduate Program in Law at Unochapecó, deals with the relationships between the national and Santa Catarina legal frameworks for Science, Technology and Innovation with the principle of sustainability.

According to the authors, legal principles, in addition to being endowed with normative force, give the various branches of law systematic coherence and scientific autonomy.

Based on this premise, the authors begin to investigate the role of sustainability in the organization of normative STI systems based on the gradual search for improvements that result in benefits for current and future generations.

Professors Junior Roberto Willig and Wilson Engelmann, Doctors and Masters in Law from UNISINOS, the former: Professor of the Graduate Course in Law at UNIVATES; and the latter: Professor of the Graduate Program in Law – Master's and Doctorate – and of the Master's

Professional in Company and Business Law, both from UNISINOS – Rio Grande do Sul institutions recognized for their insertion in SCT activities – in chapter 2, entitled "The Constitutionalization of Innovation in Brazil", describe the process of insertion of STI in the text of the Federal Constitution of 1988, via Constitutional Amendment no. 85/2015, and discuss the consequences of raising the matter to constitutional status. The chapter deals with issues of great importance for the sector linked to innovation, which, unfortunately, are not explored as they should by the science of law.

It is worth pointing to items that deal with the symbolic value conferred by constitutionalization to innovation and how it became possible, after 2015, to deal with the matter from a constitutional basis.

Considering the preeminence and prominence exerted by the Constitution in the legal systems of Democratic States of Law, the process narrated by the researchers significantly alters the applicable rules of interpretation and demands new positions from the sectors involved in the triple helix of innovation.

Giani Burtet, PhD student in Technology and Innovation Management at Unochapecó and Master in Law at the same institution; Claudio Alcides Jacoski, PhD in Production Engineering from UFSC, Chancellor of Unochapecó, Professor of the Stricto Sensu Graduate Programs in Technology and Innovation Management and in Accounting Sciences and Administration at Unochapecó, and Innovation Agent at Pollen Scientific and Technological Park; Rodrigo Barichello, PhD in Production Engineering from UFSC, Professor of the Stricto Sensu Graduate Programs in Technology and Innovation Management and in Accounting Sciences and Administration at Unochapecó, and Executive Director of Pollen Scientific and Technological Park, sign the third chapter: "Santa Catarina's science, technology and innovation policy as a regulatory instrument and driver of innovation".

The text deals with the role of Santa Catarina's policy for science, technology and innovation to consolidate Santa Catarina as one of the most relevant states in the country's technology and innovation sectors.

Based on a review of the history of Santa Catarina's STI policy, the authors discuss the role of the State's sectoral legislation for the construction and restructuring of the State STI Policy.

Part II of the book deals with the implications arising from the inclusion of the matter within the scope of incidences of the common and concurrent competence regimes, the necessary adaptations of Santa Catarina legislation to federal guidelines and the possibilities for the State of Santa Catarina and for the Municipalities to supplement and complement federal legislation, considering its particularities, such as the diversity of production chains, and the vocation for exports and tourism, on the one hand, and, on the other, bottlenecks related

to infrastructure and the pressure of economic activities on the environment.

Chapter 4, which begins the second part, raises the main impacts arising from the enactment of Constitutional Amendment no. 85/2015 and amendments from federal STI legislation to state sectoral legislation. The text written by Jaqueline Kelli Percio, Master in Law from Unochapecó, and Reginaldo Pereira also points out the actions that the State has been taking in the legislative sphere to adapt its legislation to the new constitutional and legal rules that deal with the subject.

Written by Cristiani Fontanela, PhD in Law from UFSC, Professor of the Stricto Sensu Graduate Program in Law at Unochapecó and Coordinator of the Center for Innovation and Technology Transfer (Núcleo de Inovação e Transferência de Tecnologia – NITT) at Unochapecó, and by Andréa de Almeida Leite Marocco, PhD in Law from UFSC, Professor of the Stricto Sensu Graduate Program in Law at Unochapecó and Dean of Research, Outreach, Innovation and Graduate Studies at Unochapecó, Chapter 5 aims to verify the potential of the new legal framework in generating security and encourage the technological transfer of knowledge produced in STI institutions to society and the productive sector.

The ability of the new legal framework to transform research into assets and provide an adequate environment for innovation is tested by the authors in three legal instruments provided for in Decree no. 9.283/2018: incentives to the development of cooperative projects involving companies, STI institutions and non-profit private entities; the Centers for Technology Innovation (CTI); and facilities for the technology transfer from public STI institutions to the private sector.

In "Socio-environmental sustainability in the principles of action of the Centers for Technology Innovation of Higher Education Institutions of the ACAFE System", title of the sixth chapter, Felipe Migosky and Reginaldo Pereira start from the STI norms of Brazil and of the state of Santa Catarina to test the hypothesis that the principles of action of the CTIs of HEIs (Higher Education Institutions) of the ACAFE System observe socio-environmental sustainability criteria. The objective of the research is to verify if this criterion integrates the actions of the CTI under analysis.

Chapter 7 is written by Raquel von Hohendorff. With a postdoctoral degree in Public Law from Universidade de Las Palmas de Gran Canaria (Spain), Doctor and Master in Public Law from UNISINOS and Professor and Researcher of the Graduate Program in Law – Master and Doctorate – at UNISINOS, in the text entitled "A Proposal for the Improvement and Study of Incubated Companies in Technological Poles, in Santa Catarina, in the Light of the Safe by Design Tool", von Hohendorff exposes the theoretical foundations and reasons that justify a research proposal, together with innovative companies incubated in Technological Poles in the State of Santa Catarina, with the aim of

verifying the possibility of applying Safe by Design in their production processes, in order to consolidate Sustainable Development Goal 12 (Sustainable Production And Consumption).

The chapter closing the book was written by Jaqueline Kelli Percio and Reginaldo Pereira. Therein, the authors indicate some proposals for improving the Santa Catarina legislation on STI, and of the municipalities that make up the State, due to the opening conferred by the new rules that guide the regimes of concurrent and common competences which began to guide the legislative and administrative activities of the State and the Municipalities.

Finally, the expectation is that this collection will present subsidies for legislators, public managers and agents of the state and municipal ecosystems of Science, Technology and Innovation; that it will serve as a reference source for researchers from different areas interested in the subject; and more significantly, that it subsidize the creation of a policy for Science, Technology and Innovation in Santa Catarina that is, from a legal point of view, safe, advanced and sustainable.

Reginaldo Pereira[1]

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Part 1.

STATE OF THE ART OF THE FEDERAL AND SANTA CATARINA LEGAL FRAMEWORKS FOR SCIENCE, TECHNOLOGY AND INNOVATION AND THEIR LINKS TO SOCIO-ENVIRONMENTAL SUSTAINABILITY AND THE PROTECTION OF HUMAN RIGHTS

Law of innovation and sustainability: problematizations based on the Brazilian legal framework and on the legislation on science, technology and innovation in Santa Catarina

Felipe Migosky*
Reginaldo Pereira**

Introduction

Is it possible to state, as some Brazilian authors already do, that there already are legal elements capable of providing support for the formation of an autonomous branch, at least in Brazilian law, dedicated to regulating science, technology and innovation processes?

The answer to the above question demands a verification process regarding the existence of a systematized and autonomous set of rules and legal principles that will order the new branch of law.

We could point out 2004, the year Law no. 10.973 was sanctioned, setting measures to encourage innovation and scientific and technological research in the productive environment, as the starting point for the right to innovation in Brazil. Since then, an Amendment to the 1988 Constitution of the Federative Republic of Brazil has been promoted, besides a series of improvements in several Federal Laws that deal specifically with innovation, or that create a legally favorable environment for its development.

There are also principles that, in addition to normative force, give logic to the tangle of rules that deal with the subject and, thus, allow legal operators to interpret them systematically.

Among the principles, this chapter is dedicated to verifying the relationship between technological innovation and socio-environmental sustainability.

Innovation processes are the result of the interests of multiple actors: companies, government and research institutions, which at the same time impact society and influence it to mobilize in favor of an increase in production.

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Profit, the desire to lead, as well as the desire to create and enjoy new things, employment and income levels, can be listed as reasons for encouraging the search for new productive arrangements that result in economic growth.

This stimulation occurs in a variety of formal and informal ways. In States of Law such as Brazil, its legal institutionalization is assumed. And in the case of Brazilian legislation, it appears, in principle, that the Brazilian legal framework for STI seems to be indifferent to the risks of technological innovation.

Thus, the aim of this chapter is to identify whether the right to innovation includes socio-environmental sustainability criteria.

The triple helix of innovation

At the beginning of the 20th century, Joseph Alois Schumpeter sought to deepen explanations on how the capitalist economy functioned, until then conceived as a balanced cycle. For Schumpeter (1985, p. 48), this cycle was not like the gradual organic growth of a tree, but composed of "spontaneous and discontinuous changes" – also known as disturbances – carried out by producers and which, instead of being influenced by consumer tastes, are themselves responsible for instilling needs in these consumers.

With that, Schumpeter (1985, p. 48) established the bases for the concept of innovation currently adopted. According to the author, the production of new things, or the same things with a different method, presupposes new combinations of materials and forces, which can result in the following kinds of innovation:

1) The introduction of a new good or a new type of good;
2) The introduction of a new production method, which may even consist of a new way of commercially handling a commodity;
3) The opening of a new market;
4) The conquest of a new supply source of raw materials or semi-manufactured goods; and
5) The establishment of a new organization of any industry.

Schumpeter (1985, p. 62) also expressly distinguished invention from innovation, as the former would have no economic relevance until put into practice. And this is the task of the typical entrepreneur – in his conception, this is the agent who performs "new combinations".

As incentives for the entrepreneur to carry out this activity, Schumpeter (1985, p. 65) identified pecuniary gain, the mere desire to compete – regardless of the financial result – and, still, the joy of creating.

Effectively, companies innovate because of the profit that this activity provides. For example, in innovating in production processes to increase

production, costs are reduced and profit margins are increased. Or, in the case of product innovation, the company obtains a position of monopoly either due to a patent (legal monopoly) or to the time it takes for competitors to imitate it. Hence, in this period, it can set higher prices than in a competitive market (OECD, 1997, p. 36-37).

Also identified, among the reasons for innovating, are reactive or preventive postures, consisting of avoiding losing market space to an innovative competitor or imposing higher technical standards for the products themselves (OECD, 1997, p. 38).

The privileged situation generated by an impactful innovation is soon overcome by a wave of innovations led by other entrepreneurs, which motivates new innovations, and so on, boosting development in long cycles, as seen with the emergence of the railways in the 19th century, the introduction of fossil coal in the industry replacing charcoal around 1800, the first Technological Revolution represented by the manufacture of machines in the 1850s, the second Technological Revolution with electric motors and combustion in 1895, and the third Revolution Technological, characterized by the automation of production processes in the 1940s (MONTIBELLER FILHO, 2004, p. 66-73).

At the end of the 20th century, material culture was transformed by information technology. For Castells (2006, p. 70), the information technology revolution is also distinguished from previous industrial revolutions by its scope and the incredible speed with which its expansion occurred. While the first were limited in space or took almost two centuries to spread, largely due to imperialist purposes, the current revolution developed in the short period between the 1970s and 1990s, due to the immediate application of technology.

Rodrigues and Engelmann (2014, p. 216) point out the increase in Information Technology and Nanotechnologies as the last two waves of the Industrial Revolution, which represent "[...] an unprecedented opening to face the problems that characterize society as being at risk, especially environmental issues."

Silva and Melo (2001, p. 46) identify that innovation is essential for the survival of humanity, since with innovation the depletion of natural resources would be avoided and social inequalities would be overcome.

They also point out that innovation is necessary for the survival of nations, since those that do not adopt innovation will be dependent on nations that dominate knowledge. Thus, it is necessary to promote the dissemination of knowledge both vertically, that is, improving research, and horizontally, that is, to the greatest possible number of citizens (SILVA; MELO, 2001, p. 48).

With regard to products (goods or services), innovation takes the form of technologically new products, derived from radically new technologies, a new combination of existing technologies or the use

of new knowledge. It can also result in technologically improved products, with enhanced performance or lower costs. Technological process innovation, characterized by the adoption of new production and delivery methods or improved methods, aims at the production or delivery of innovative products that are incompatible with existing methods, or at increasing production or efficiency in the delivery of products (OECD, 1997, p. 55-56).

Regarding the technological innovation of products and processes, Fuck and Vilha (2011, p. 8) provide the Embraer ERJ 145 jet as an example of product innovation, "[...] which revolutionized the sector's market by offering the comfort and benefits of a jet plane, but with the operating costs of a turboprop aircraft [...]", and as a process innovation, they cite robotization in the car manufacturing line, whose industry is rich in innovations of this type, since the Fordism (method characterized by the serial production line, initiated by Henry Ford) of the early 20th century.

Federal Law no. 10.973, of December 2, 2004, seems to have contemplated all these assumptions by conceptualizing innovation, in art. 2nd, IV, as:

> [...] the introduction of novelty or perfectioning in the productive and social environment that results in new products, services or processes or that includes the addition of new functionalities or characteristics to an existing product, service or process that may result in improvements and in cash gain in quality or performance.

According to this definition, the innovation itself will only be configured when it is effectively incorporated into the market, since before that it is possible to qualify it only as an invention, exactly as Schumpeter already stated.

In addition, the concept of innovation can be expanded from the configuration of a new marketing method or a new organizational method in business practices, in the organization of the workplace or in external relations (OECD, 1997, p. 55).

Exemplifying once more these forms of innovation, as market innovation, Fuck and Vilha (2011, p. 8) refer to Havaianas sandals, simple and cheap products that were associated with fashion items used by celebrities. They also mention the change of the Natura company in its relationships with suppliers, in search of the exploration of Brazilian biodiversity, as a model of organizational innovation.

The fact that knowledge cannot be appropriated discourages companies from investing in innovative activities, since the benefits of innovation go beyond the company. For this reason, governments institute science and technology policies that aim to compensate for the lower market incentive. The main political tools have been the direct funding of research by governments, especially basic research, and patents (property rights) (OECD, 1997, p. 34).

Barbosa (2011, p. 4) explains that the reason for the state stimulus for innovation is that:

> Nowadays, without this action coordinating efforts, investing, stimulating industrial and particularly technological development, the economy runs serious risks of decline and of being taken to the status of a satellite of more powerful economies, to the point of compromising national independence not only at the economic and technical level, as well as at the political one.

Hence, contrary to seeing it as undue intervention in the market, the performance of public entities in promoting innovation is welcome, as has been empirically proven in Japan, which, in a few decades, due to the industrial development policies adopted, reached the technological level of the United States of America (BARBOSA, 2011, p. 4-5).

In other words, an innovation needs an idea and investment, but this investment is discouraged in a free market environment, since the creation is not, in its purity, endowed with exclusivity. That is why, in order to stimulate the growth of their economies, public entities must stimulate innovation through the socialization of the risks and costs involved or through the private appropriation of results – that is, the legal construction of an artificial exclusivity, such as that of patent, or copyright, etc., or the combination of these two instruments (BARBOSA, 2015, p. 2-3).

According to Barbosa (2015, p. 4), the Brazilian Innovation Law provides for the association of these two methods, with the socialization of costs carried out through the concession of human, infrastructural and financial resources, the interaction between scientific and technological institutions and companies and the use of the State's purchasing power. In addition, Law no. 11.196/2005 (Lei do Bem – Good Law) increases the range mentioned with the institution of tax waivers.

Hence, research institutions, especially universities, also appear in this context interacting with companies and governments. First, because they contribute to the development of human resources and the dissemination of knowledge. And second because they develop and transfer technologies to companies to make them available to society, or cooperate directly, enabling knowledge to become useful. Thus, "[...] the university is currently assuming a more fundamental role in society, one that makes it crucial for the future of innovation, job creation, economic growth and sustainability." (ETZKOWITZ, 2009, p. 41).

Each of these actors – government, business and university – has responsibilities and limitations in the context of innovation. To explain the phenomenon, Etzkowitz and Leydesdorff conceived the so-called triple helix, a figure alluding to the constant influence that actors exert on each other, and on society as a whole, in the performance of activities related to innovation (LEYDESDORFF, 2012). In this context:

> The expectation is that universities form multiplier agents for innovation and change actions; that governments contribute to the creation, improvement and consolidation of public policies, with mechanisms to encourage these actions; and that companies integrate, based on social responsibility, the development projects, as partners of the two other actors. (VIEIRA et al., 2015, p. 4).

This triple helix model is opposed to the linear one, according to which basic research, originating in universities, would be converted into innovation by companies, and represents the second academic revolution that took place in Brazilian universities[1], which is characterized by its contribution to economic and social development (ARBIX; CONSONI, 2011, p. 209-210).

Rodrigues and Engelmann (2014, p. 224) explain that "[...] this was possible with the change of paradigm from industrial society to that of knowledge society [...]", insofar as "[...] the growing need for scientific knowledge for technical progress and the speed of innovation require technological cooperation practices between the actors involved in the process of generating and disseminating innovations, the so-called triple helix."

Due to the current importance of science and technology for innovation, this depends on the interaction between sources of knowledge and resources, which leads to the formation of an innovation system integrated by universities, companies, research institutions, financial institutions and public bodies of public policies (FUCK; VILHA, 2011, p. 15).

And the functioning of the triple helix, of this complex system of interactions aimed at innovation, as Barbosa (2011, 2015) recalled, depends on normative regulation, which will be analyzed in the next section.

Brazilian legal framework for science, technology and innovation and its underlying logic

The legal framework to stimulate innovation in Brazil and provide the innovation system with greater legal security emerged in 2004, through Federal Law no. 10.973/2004, known as the Innovation Law.

Niehues (2016, p. 42-44) points out that the 2000s were marked by normative production with the aim of favoring the triple helix, notably with the advent of the Innovation Law, and to encourage – and even compell, in certain sectors of the economy – investment in the area. These norms were outlined by the author in accordance with Table 1.

1 The first would be the emergence of research, which, although having taken place in the 19th century, was observed only in the 1970s in Brazil.

Table 1. Rules that encourage investments in Research, Development and Innovation

National Electric Energy Agency	Concessionaires, permit holders and authorized companies in the electricity sector are obliged by Law no. 9,991, of July 24, 2000, to invest at least 1% of their net operating revenue in RD&I (Research, Development & Information) and in energy efficiency programs in the supply and final use of energy.
Inovarauto (Law no. 12.715/2012)	Instituted the program that aimed to encourage competitiveness in the Brazilian automotive sector, establishing goals that, if met, guarantee tax benefits to automakers. By making cars more economical and safer, investing in the supply chain, engineering, basic industrial technology, research and development and supplier training, companies may have their IPI (Tax on Manufactured Products) reduced by up to thirty (30) percentage points.
Information Technology Law	Grants tax incentives to companies in the technology sector that prove tax compliance, are producers of an item whose NCM (Mercosul Common Nomenclature) is on the list of products encouraged by law and that invest in Research and Development. Aimed mainly at hardware and electronic components.
Good Law	Established tax incentives to all legal entities that invest in Research and Development of technological innovations. The law seeks to bring the private sector closer to universities, enhancing research results.
National Petroleum Agency	Since 1998, the National Petroleum Agency has added a clause to its exploration concession contracts, determining that its concessionaires invest 1% of their gross income in Research and Development.

Source: by the authors (2022), based on Niehues (2016, p. 42-44).

The Innovation Law, in turn, intended to leverage technological innovation in Brazil by encouraging interaction between companies and STI institutions.

Facilitating the general understanding of the Innovation Law through a more in-depth systematization of the chapters inserted by the legislator, Barbosa (2011, p. 6) synthesized its provisions into five large groups of norms:

1) Creating an environment conducive to strategic partnerships between universities, technological institutes and companies: characterized by so-called “horizontal” articulations between the private sector and STI institutions, not including unilateral concessions such as tax incentives. It comprises, according to the author, articles 3, 4, 5 and 9, and, given the compatibility of the matter, the new articles 3-A, 3-B, 3-C, 3-D and 9-A;
2) Encouraging the participation of science and technology institutions in the innovation process: considered the main body of the Law, it encompasses articles 6, 7, 8, 14, 15 and 16, as well as, in our opinion, the recent article 14-A. It is noteworthy

that, in this group, the requirement to create a management body for innovation and articulation activities is included, that is, the NIT;

3) Researcher-creator incentive norms: these are articles 8, 11, 13 and 15 – now reinforced by articles 14-A and 21-A –, which provide for possibilities of additional income to the scientists for the development of the research and for the use of the creation by themselves or by third parties;
4) Incentive to innovation in the company: shaped by articles 19, 20 and 28, which establish measures for granting financial resources, exercise the State's purchasing power and tax incentives;
5) Appropriating technologies, portrayed by only one provision, article 12, which will suffer harsh criticism later on.

Using the theory of human behavior elaborated by Amarthya Sen as a model of analysis, which distinguishes the existence of self-interested behavior and plurinterested behavior, Oliveira (2012, p. 1615-1617) states that a law that designs "[...] instruments that intend to bring Universities closer to the productive sector, must be concerned with the development of both the individualistic and the collectivist aspects."

This is also the understanding of Santos (2004, p. 85):

> Law is related to the economy, to politics and, without a doubt, to the development of the country, whether scientific, technological and innovative, or socioeconomic. Law regulates relations and conduct; it must avoid the influence of external conditioning interests if these are contrary to the common good – its main objective. Law gives legitimacy and limits power – it seeks social justice.

Before examining the content of the Innovation Law, Oliveira (2012, p. 1617) exposes, in summary, the following problems: what should be expected from this law that intends to encourage technological progress by bringing the academic and productive sectors closer together? And what instruments should be established to stimulate these desired behaviors, that is, inventive activities?

> In response to the questions raised, one can expect the establishment of a Law that stimulates innovation movements (in the individual perspective), thinking about mechanisms to protect the interests directly involved in the creation process, but also in governance measures (individual control versus collective control) of rights derived from the guardianship of creations. The idea here is to create a Law able to encourage individuals to invest resources in the process of technological innovation, but also to create mechanisms that establish a more efficient process in return to the community. This, in short, is the expected practical effect. (OLIVEIRA, 2012, p. 1617-1618).

Contrary to this expectation, however, Oliveira (2012, p. 1623-1624) notes that the centrality of the object of the Innovation Law is intellectual property with an exclusive character, which operates in the logic of solely self-interested behavior. In addition, it deals with this

model of behavior that influenced the law – which is "[...] specialized in providing information to the public domain (Mediate purpose – serving the collectivity) by granting private incentives to the author (Immediate purpose – the fulfillment of individual interests) [...]" – as a dogma, insofar as it cannot be empirically justified.

Rossetto (2017, p. 48-49) presents an important criticism of the form of interaction between STI institutions and companies contemplated in the Law, which, stated the author, provides the "private appropriation of knowledge produced by the State":

> The Technological Innovation Law of 2004 did not privatize the public structure of the State's scientific institutions, but it did privatize their results, encouraging Public Institutions to work for private legal entities, creating a legal obstacle to the publication of results and financially encouraging public researchers to do so. In addition, so that research funding from private legal entities in public institutions could be funded with tax benefits, a reduction in the Income Tax was established [by Law n. 11,196/2005].

Recently, Law no. 13.243/2016, published in the Official Gazette of the Union on January 12, 2016, had a significant impact on Law no. 10.974/2004, as well as promoting specific changes in eight other Federal Laws indirectly related to the processes of innovation and technology transfer in Brazil, namely:

Table 2. Laws partially amended by Federal Law n. 13,243/16

Law number	Object of the law
Law no. 6.815/80[2]	Defines the legal status of foreigners in Brazil
Law no. 8.666/93	Establishes rules for biddings and contracts by Public Administration
Law no. 12.462/12	Establishes the Differentiated Regime for Public Procurement (RDC)
Law no. 8.745/93	Provides for contracting for a fixed period of time to meet the temporary need of exceptional public interest, within the scope of the Federal Government
Law no. 8.958/94	Provides for relations between federal institutions of higher education and scientific and technological research and support foundations
Law no. 8.010/90	Provides for imports of goods intended for scientific and technological research
Law no. 8.032/90	Provides for the exemption or reduction of import taxes
Law no. 12.772/12	Deals with the structuring of the Federal Teaching Careers and Positions Plan

Source: by the authors (2022).

2 Law no. 6,815/80 was revoked by Law no. 13.445, of May 24, 2017 (called the Migration Law), but kept in force until a period of 180 days had elapsed from the publication of the latter, which took place on May 25, 2017.

Thus, the new legal framework for STI in Brazil is represented by Law no. 10.974/04 with the amendments of Law no. 13.243/16, as well as other sparse provisions dealing with human resources, state purchases, university support foundations and the importation of goods.

Among the changes implemented in the Innovation Law, the formalization of private STI institutions, the expansion of the role of NITs, the reduction of some of the obstacles to the importation of inputs for R&D, the formalization of grants to encourage innovative activity, among others, stand out among other tools aimed at strengthening the stimulus to the participation of STI institutions in innovation activities associated with the productive segment (RAUEN, 2016, p. 24).

On the other hand, the opportunity to expressly foresee requirements, goals and instruments for achieving sustainable development was lost, and thus the Brazilian legal framework for STI reveals the intention of leveraging the country's economic development, disregarding the other pillars of sustainability, which are the social and the environmental (PEREIRA, 2015).

In this sense, the Brazilian legal framework for STI is pulling away from the concept that guided the development of another contemporary rule (Law no. 13.123/2015), the new Biodiversity Law, which expressly provides for rights and obligations relating to "[...] the fair and equitable sharing of benefits derived from the economic use of finished products or reproductive material derived from access to genetic heritage or associated traditional knowledge, for the conservation and sustainable use of biodiversity [...]" (art. 1, item V), as well as stating that access to genetic heritage and associated traditional knowledge for practices harmful to the environment, cultural reproduction and human health and for the development of biological and chemical weapons is prohibited (art. 5).

Constitutional foundations and criticism of the new Brazilian legal framework for STI

The Innovation Law is based on articles 218 and 219 of the Constitution of the Republic. The scientific, technological and innovation development provided for in such devices implements the fundamental right to development provided for in art. 3, item II of the Fundamental Charter[3].

The political value of research in Brazil is determined in Paragraphs 1 and 2 of Art. 218: "in view of the public good and the progress of science, technology and innovation" and "[...] the solution of Brazilian

3 Art. 3 The fundamental objectives of the Federative Republic of Brazil are: [...] II – to guarantee national development;

problems and for the development of the national and regional productive system."

Another constitutional device related to the STI is Art. 5, Subparagraph XXIX[4], which highlights the submission of intellectual property to the social interest of the country, instead of the return of investments to companies.

In addition, the right to an ecologically balanced environment, essential to a healthy quality of life (art. 225 of the Federal Constitution[5]), is one of the elements that make up the dignity of existence, elevated to the foundation of the Federative Republic of Brazil (art. 1, subparagraph III of CF[6]).

Still, the defense of social equity and the environment becomes mandatory for the realization of a free, fair and solidary society, in which there is no poverty, exclusion and inequalities, thus defined as fundamental objectives of the Republic (art. 3, subparagraphs I, III and IV of CF[7]).

Thus, the aim of innovation cannot be other than the achievement of human dignity, the soul of the constitutional norm, which comprises the objectives also mentioned.

Niehues (2016, p. 65), in a monographic work that analyzed the new STI legal framework in detail, found that it granted greater autonomy, flexibility and reduced bureaucracy for the interaction of the triple helix agents, and recorded that "[...] The concern that arises is that the increasing development of science, technology and innovation disproportionately benefit the private sector, to the detriment of the public sector."

Arcuri (2017, p. 39) draws attention to the fact that the new STI legal framework did not dedicate any rules on governance of occupational risks, which means that workers, although they are the first to come into contact with the new materials that the legislation encourages to be researched and produced, will not have even been consulted.

Commenting on changes made to Law no. 10.973/04, such as the institution of the NIT under private law and the delegation of tasks to

4 Art. 5 [...] XXIX - the law will assure authors of industrial inventions temporary privilege for their use, as well as protection for industrial creations, trademark ownership, company names and other distinctive signs, in view of the social interest and the technological and economic development of the country;

5 Art. 225. Everyone has the right to an ecologically balanced environment, an asset for common use by the people and essential to a healthy quality of life, imposing on the Government and the community the duty to defend and preserve it for present and future generations.

6 Art. 1 The Federative Republic of Brazil, formed by the indissoluble union of the States and Municipalities and of the Federal District, is constituted in a Democratic State of Law and is founded on: [...] III - the dignity of the human person;

7 Art. 3 The fundamental objectives of the Federative Republic of Brazil are: I - to build a free, just and solidary society; II - ensure national development; III - eradicate poverty and marginalization and reduce social and regional inequalities; IV - promote the good of all, without prejudice of origin, race, sex, color, age and any other forms of discrimination.

Support Foundations, Rossetto (2017, p. 51) states that "[...] Law 13.243, of January 11, 2016, consummated the goal of privatizing science and technology generated by the State, which had been a goal pursued since the second half of the 1990s."

Rossetto (2017, p. 51-53) verified with great perspicacity the unconstitutionality (although he calls it illegality) of the Innovation Law provision, noting that the prohibition of dissemination of research provided for in art. 12 of Law no. 10.973/04[8] directly offends the principle of publicity provided for in art. 37 of the Constitution of the Republic and also the following constitutional precepts: i) the construction of a solidary society (Art. 3 I of the CF), the eradication of social inequalities (Art. 3 III of the CF) or the reduction of social inequalities (Art. 170 VII of the CF), the promotion of the good of all (Art. 3 IV of the CF): due to the fact that the Innovation Law encourages the private appropriation of knowledge, leading to the exploitation of technology for profit; ii) the freedom to disseminate knowledge, fundamental to guaranteeing everyone's right to education (Art. 205, caput and subparagraph II of the CF); iii) free competition (Art. 170, subparagraph IV of the CF), as it provides knowledge only to some companies and prevents competitors from receiving information and technology.

Andrade (2017, p. 85-86) carried out a quantitative analysis of the text of the new STI legal framework in order to identify words that could show some "[...] concern with the risks, impacts and occupational and social implications of new technologies in general and nanotechnologies in particular."

The author then concluded that such a concern could not be found in the Innovation Law, and added that "[...] simple technological development will not necessarily promote social gains such as equity and justice." (ANDRADE, 2017, p. 87).

In fact, it can be seen that the legislator, in addition to not providing for any mechanism to limit economic progress, appropriated terms such as "right" and "participation" to legitimize solely the objectives of the market.

Fonseca (2017, p. 118) analyzes that the new legal framework for STI:

> [...] crystallizes a vision of a future in which the main benefits of scientific knowledge produced by public institutions must be achieved through its transfer to private companies, making them more competitive and, in this way, able to contribute to the economic and social growth of the country, through more jobs and taxes.

8 Art. 12. It is prohibited for a director, creator or any civil employee, military officer, employee or ICT service provider to disclose, report or publish any aspect of creations whose development they have directly participated in or become aware of by virtue of their activities, without first obtaining express authorization from ICT.

Despite this, he emphasizes that this imaginary already exists in the country, since the enactment of the Innovation Laws (2004) and Good Law (2005), without the expected results having been produced, that is, the development of a highly technological and innovative industry (FONSECA, 2017, p. 119).

Thus, the author observes that the discourse of university-company interaction, instead of being promoted by local entrepreneurs, is driven "[...] by the so-called 'high clergy of the hard sciences', or 'entrepreneurial academics', trained to interact with innovative companies." (FONSECA, 2017, p. 119-120).

From this, Fonseca (2017, p. 121) formulates the hypothesis that the implementation of this innovationist model

> [...] is the result of a conscious option on the part of the dominant scientific class – ideological and even political – to reproduce, even if in a peripheral way, the capitalist dynamics that, in advanced countries, but also until now, maintains its socially and economically privileged situation.

One can go beyond the limits of the argument to empirically verify this issue, based on the processing of the bill that resulted in the New Brazilian Legal Framework for STI, which is available on the House of Representatives and the Federal Senate websites.

Apparently, the matter entered the House of Representatives as Bill (PL) no. 2177/2011, and was signed by ten federal representatives from different political groups.

In its initial version, the bill instituted the National Code of Science, Technology and Innovation and included very broad wording, totaling 81 articles. The explanatory memorandum signaled the importance of imprinting agility and reducing bureaucracy in the legislation governing the STI so that the country could reach levels of speed and excellence in the development of new products and processes, thus becoming capable of competing on the international scene and avoiding perennial underdevelopment.

The conception of development adopted in the legislative proposal was that innovation, by itself, will culminate in an increase in the regional and national HDI (Human Development Index), generating new jobs, leading to the circulation of wealth and, as a result, an increase in revenue that reverts to all other public policies, feeding a virtuous circle.

As soon as it was presented, a special commission was set up to issue an opinion on the Bill. On April 1, 2014, the designated rapporteur, Deputy Sibá Machado, from the Workers' Party, presented an opinion clarifying that the proposed project was the result of a suggestion by representatives of the Brazilian scientific community. He also pointed out that, with the aim of receiving contributions from organized civil

society on the subject, the Commission held public hearings and seminars.

In these spaces, as explained in the report, we can observe that most participants were representatives of innovation agents. On only one occasion did the Attorney General's Office participate, as well as representatives of bodies linked to environmental protection, specifically the Federal Attorney of IBAMA and the Ministry of the Environment, exclusively to address the issue of access to biodiversity.

As the rapporteur added, due to the complexity of the matter and the diversity of approaches offered by the various guests at the public hearings and seminars, it was decided a working group should be formed to examine the various contributions, which was also integrated, in its broad majority, by entities or bodies that promote innovation.

In the considerations on the proposal examined by the commission, the rapporteur explained that, in order to avoid allegations of unconstitutionality due to a defect in the initiative, it was decided that the innovation law would be modified in force, instead of replacing it with a new diploma. Still some topics that were controversial due to their impact on other topics that were still being worked on within the scope of the Executive Branch, such as the treatment of biodiversity, and others that had more effective administrative or legal alternatives for their solution, such as the acquisition of assets and the treatment given to imports, were radically reduced or even suppressed.

In addition, the commission itself reported the realization that the new framework could run into material unconstitutionality, considering that until then there was no express provision on the articulation between public and private entities, nor on the transfer of public resources to private research entities. Then, in the midst of processing the bill – L 2177/2011 –, the Proposal for Constitutional Amendment (PEC) no. 290, of 2013, authored by Deputy Margarida Salomão, from the Workers' Party, was presented, being approved and enacted in the form of Constitutional Amendment n. 85, of February 26, 2015[9].

After being scheduled twice for deliberation in plenary, on March 3 and 4, 2015, without consideration of the matter, an urgent request was presented and approved for the consideration of PL 2177/2011. Following some withdrawals from the agenda and the vote on some plenary amendments, the project remained approved on July 9, 2015.

9 In analyzing the PEC's processing, only one note of possible unconstitutionality was observed, which was by the Commission for the Constitution of Justice and Citizenship (CCJ) of the House of Representatives, with regard to the transfer of public resources to private entities, without the requirement of a counterpart. The issue was resolved in the CCJ itself, adding the need for a counterpart for the transfer of public resources to private individuals, and, later, by the Special Commission designated in that legislative house, that added wording stating that the counterpart could be financial or non-financial. The Special Commission's report also reveals that there were three public hearings with the aim of broadening the debate on the subject, which were also attended only by representatives of bodies/entities that promote innovation, as well as inventors. The PEC received only one vote for non-approval, in the first round of voting in the House of Representatives, while 399 federal representatives voted in favor.

Entering the Federal Senate as House Bill no. 77/2015, the matter was quickly approved by the Constitution, Justice and Citizenship Commission. Afterwards, in joint analysis by the Economic Affairs Commission and the Science, Technology, Innovation, Communication and Informatics Commission, a public hearing was held on November 18, 2015, with the restricted presence of representatives of the National Forum of Innovation and Technology Transfer (FORTEC), the National Council of State Research Support Foundations (CONFAP), the National Council of Foundations to Support Higher Education Institutions (CONFIES), the National Confederation of Industry (CNI) and the University of Brasilia (UnB).

On November 24, 2015, the opinions were approved by the aforementioned committees, including three amendments, and, without receiving amendments from the plenary, the PL was approved on December 9.

According to Nazareno (2016, p. 13-14), when it was received for presidential sanction, the new Law was sanctioned with 11 (eleven) vetoed provisions, due to positions taken by the Ministries of Finance (MF) and Planning, Budget and Management (MPOG). And, although the vetoes were overturned in May 2016 by a large majority of representatives (276 votes to 2), due to the low presence of Senators, the absolute majority of 41 senators necessary for their overthrow was not achieved. However, the vetoed devices were included as Amendments to Provisional Measure no. 718/16, which was converted into Law no. 13.322/2016.

In addition, on February 8, 2018, Decree no. 9.283/2018 was published and entered into force; it regulates the new Brazilian STI legal framework and is the result of the great involvement of innovation agents.

The then Ministry of Science, Technology and Innovation (MSTI) was in charge of editing the regulation and, for that purpose, opened public consultation through the Participa.br digital platform.

At first, for thirty days, suggestions were collected on the provisions of the Law that expressly required some type of regulation. In addition, it was possible to point out other topics that should be regulated or have their current regulations improved.

In the second stage, the MSTI made the draft of the Decree available to receive, also within 30 days, contributions on each provision. For the elaboration of the final regulation proposal, under its charge, the MSTI did not rule out new rounds of discussion, just as it stated that, during the two phases of the consultation, it intended to intensify its agenda of public events for the discussion of the proposals and consequent mobilization of those interested to participate in discussions on Participa.br.

Despite this, in a primary analysis, there are practically no socio-environmental sustainability criteria in Decree no. 9.283/2018. Carrying out a search similar to that set out in Annex I, carried out by Andrade (2017) in Law no. 10.973/2004, it appears that: a) words related to the radical "environment" are almost completely linked to "innovation-promoting environments"; b) words related to the root of "social" are almost entirely linked to references made to business companies and their articles of incorporation; c) the term "risk" appears practically only in the expression "technological risk", conceptualized in Art. 2, Subparagraph III of the Decree as "[...] possibility of failure in the development of a solution, resulting from a process in which the result is uncertain due to insufficient technical-scientific knowledge at the time when the decision is taken to carry out the action."

In turn, the term "impact" indicates two socio-environmental sustainability criteria, however of little expression. In Art. 64, Paragraph 2, Subparagraph VI, which deals with the choice of the best proposal in the bidding waiver process to contract, by the public authorities, engineering work and services classified as products for research and development, environmental impact is established as one of the six criteria. And, in the contracting of this work and services in the integrated modality, as requirements of the engineering draft, alongside several others – such as public interest, economy in its use and ease of execution – the parameters of adaptation to environmental impacts and accessibility are inserted (Article 69, Paragraph 2, Subparagraph IV).

These data indicate that the Decree remained faithful to the predominance of economic sustainability adopted in the Brazilian STI legal framework, although it cannot be said that the insertion of measures aimed at in-depth assessment of the social and environmental impacts of innovations goes beyond the limits of the law, as it remained timidly included in the devices mentioned in the previous paragraph. In addition, such measures would better comply with the Federal Constitution.

A larger investigation into the long text of Decree no. 9.283/2018, which has 84 articles and is very recent, is still needed. More research is also needed to draw precise conclusions about participation in the construction of the regulation.

In any case, the data reveal how the portion of the Brazilian scientific community that promotes and develops innovation had the political strength to quickly institute normative instruments capable of providing them with economic gains.

The National Union of Teachers of Higher Education Institutions (ANDES-SN, 2017, p. 10) reinforces this idea by stating that the changes produced by the new legal framework occurred "[...] without a deeper analysis and without communicating with the teaching and research

organizations, resulted in the consensus of some representatives of the academic community and political leaders [...]" and show the continuity of the reform of the State in the academic field, already verified since the creation of the support foundations.

ANDES-SN (2017, p. 12) complements that:

> Many claim that the 'Legal Framework' is the result of a struggle by the scientific community. This is partly true, as several academic leaders envisioned the possibility of solving historical problems such as, for example, the difficulty of importing material for research, the rigidity of the rules for the acquisition and sale of services and products on the market, the bureaucracy in the processes of fundraising and accountability. The business community, in turn, was not directly interested. Entrepreneurs are linked to the dependent model of economic development and mistakenly see the development of S&T as an innovation, just as the purchase of equipment and instruments, capital goods, which increase productivity and profit.

In its booklet aimed at exposing the risks that may occur to scientific production and public research institutions in Brazil as a result of Law no. 13.243/2016, ANDES-SN (2017) contests the blame attributed to public research institutions for the supposed poor-quality research they produce, simply because it does not meet market objectives.

The document highlights the damage to the rights conquered by the career of federal teaching professionals, notably with the relaxation of the public tender rule and the regime of exclusive dedication, as well as the privatization of knowledge due to the deepening of the neoliberal project contained in the new STI legal framework, verified both in the opening of legislation to enable greater use of facilities and public resources by private-law legal entities interested in innovation, and in stimulating research that is of interest only to private capital (ANDES-SN, 2017).

In several passages of the booklet, there is mention that the new legal framework for STI goes against the grain of the university concept defended in Notebook 2 of ANDES-SN, which had already listed the Guidelines for the Definition of Academic Policies in Science and Technology (see Annex B of this work).

In the presentation of this publication called Cadernos da ANDES n. 2, it states that:

> [...] the formulation that originated this version of Caderno 2 [fourth edition] was elaborated by higher education professors from all over the country, based on discussions about the restructuring of the university carried out since 1981, in symposiums, meetings, internal assemblies and congresses. (ANDES-SN, 2013, p. 11).

Chapter II of the referred Notebook is dedicated to Science and Technology. This chapter begins with harsh criticism and important questions about STI policies:

> Scientific and technological knowledge – despite its importance for the survival of humanity and the advancement of social and economic development – is appropriated by a minority, which prevents the socialization of its benefits. Technology increasingly gains the character of a commodity, being treated as a technical package or a means of social and political control. Thus, via scientific-technological development, the use of natural resources and energy resources, the ownership and distribution of land, the division and use of work and the distribution of income are increasingly controlled, in addition to enabling undue intervention in the priorities of political action. Discussing science and technology from the perspective of building a fair and egalitarian society requires, on the one hand, seeking new answers to old questions, such as: what would motivate the introduction of inventions and innovations in social and human relations in a capitalist economy? What would be the social cost of such inventions and innovations? Wouldn't it be urgent to consider the potential social effects of the absence of work, the drop in quality of life and the destruction of ecosystems with the indiscriminate adoption of technological innovations? How, in this context, is the issue of public university – private company relations placed? On the other hand, it is important to deepen the debate on a different knowledge and scientific-technological rationality, on the various forms of use and appropriation of nature, the main reason for socio-environmental conflicts, on the neglect of public policies, both on a global and national scale. (ANDES-SN, 2013, p. 32).

ANDES-SN (2013, p. 32) states that it "accumulated a significant critical collection in the matter", in the perspective of "[...] building, in Higher Education Institutions (HEIs) in general and public research institutes, an alternative policy for science and technology for the country." And, throughout the chapter, it problematizes the issue, based on the following main ideas:

- The addition of the term "innovation" to the binomial "science and technology" was not harmless, but a way to elevate it to the condition of a central objective of scientific research;
- Since companies invest little in research in Brazil and in Latin America, practically all scientific research is concentrated in the public sector, especially in universities and public research institutes; now, therefore, research starts to have its value measured by the adaptation to the market;
- A privatizing strategy for STI was adopted, which is characterized, among other factors, by the devaluation of teaching and scientific careers, by attracting researchers with advisory services, participation in projects contracted by companies and research scholarships for salary complementation, and by the intervention of structures such as the CITs and support foundations.

It is clear, therefore, that the Brazilian legislation that aims to stimulate STI, even with a recent reformulation, has not yet been able to foresee mechanisms aimed at implementing the constitutional precepts that guide a model of democratic, inclusive, sustainable innovation, nor did it establish goals or principles aimed at directing innovation towards social and environmental well-being.

On the contrary, the recent legal framework for Brazilian STI deepens developmentalism – that is, a focus on economic growth – as the main objective of sectoral policy. And it should be noted that this is a deliberate action by certain actors who, though aware of the possible constitutional obstacles to the validity of the new law, tried to prepare their ground with the edition of Constitutional Amendment n. 85/2015, which "[...] amends and adds provisions to the Federal Constitution to update the treatment of science, technology and innovation activities."

Constitutional Amendment n. 85 made the possibility of public encouragement to innovation clear, a term that until then had not expressly appeared alongside scientific and technological research, and allowed for a more distinct interaction between public authorities and private entities.

Remembering what was already mentioned above based on a publication by ANDES-SN (2013) is key: that the "[...] addition of the term 'innovation' to the binomial 'science and technology' was not harmless, but a way to raise it as the central objective of scientific research [...]", in order to understand the privatist and developmentalist logic behind the Brazilian STI legislation, which includes the attempt at its constitutional justification.

Alongside this, Lustosa (2010, p. 213-214) identifies a series of factors that induce companies to adopt healthier practices for the environment, ranging from internal aspects, such as cost reduction by increasing efficiency; to external pressures, specifically from final and intermediate consumers, organized groups and even individuals interested in the environmental cause; as well as investors. The case of environmental regulation is worthy of attention, in that it "[...] influences the selection process of innovations to be adopted, because the market may not be able to do so, while the institutional environment may also act in this selection process through legislation, subsidies, credits, financing and other instruments."

It is therefore convenient to analyze whether innovation and socio-environmental sustainability are compatible phenomena, and whether there is the possibility of privileging this aspect in the regulation of the matter.

Socio-environmental sustainability in innovation law

As Santos (2004, p. 96-97) points out, the STI is an indispensable means of guaranteeing the right to development, which the author recalls as a human right enshrined in the Declaration on the Right to Development and in the International Covenant on Economic, Social and Cultural Rights. And she states that "[...] development, in this context, does not only refer to individual rights, such as the rights to education, health, work. But the collective right to development

[...]", understood as belonging "[...] to the entire population the right to the well-being resulting from it, to free and meaningful participation and fair distribution of benefits that derive from it."

Santos (2004, p. 101-102) argues that

> [...] intellectual property can promote technology capable of minimizing environmental and social impacts, replacing raw materials, investing in people's education, health, reducing social inequalities, redistributing income and guaranteeing the quality of the product on the market.

Vasconcelos et al. (2015, p. 5), in a study carried out from the perspective of Administration, state that "[...] innovation and sustainability, strategically, incorporate antagonistic perspectives [...]", but that "[...] innovation, in turn, can corroborate, for example, the elaboration of more efficient and cleaner technologies."

In their research, the authors carried out a quantitative analysis of Brazilian and European industry, based on indicators of innovation, sustainability and profitability, and found that the adoption of innovation strategies and social and environmental sustainability are capable of conferring a more competitive position to a company in the market, translated into greater profitability.

In this same perspective, that the preservation of the environment is characterized as a business opportunity for companies, Lustosa (2010, p. 209) highlights the strategy of adopting environmental technologies, which are obtained through innovations and comprise the following species: i) technologies to clean up the environment (which remedy the pollution that has already occurred); ii) technologies that save natural resources (which use fewer inputs); iii) cleaner technologies (which emit less pollutants per unit of product); iv) control technologies (which monitor pollution levels).

This context suggests a paradigm of weak sustainability, characterized by the prestige of the economic aspect over social and environmental aspects, or in which there is an equivalent treatment between the pillars of sustainability.

For Barbieri et al. (2010, p. 150-151), the expected benefits of innovation must be significant or non-negligible in the three dimensions of sustainability, which would be configured as shown in Chart 4.

Chart 3. The three dimensions of sustainability in innovation

Social dimension	Concern about the social impacts of innovations on human communities inside and outside the organization (unemployment; social exclusion; poverty; organizational diversity, etc.).
Environmental dimension	Concern about environmental impacts from the use of natural resources and pollutant emissions.
Economic dimension	Concern with economic efficiency, without which they would not perpetuate themselves. For companies, this dimension means obtaining profit and generating competitive advantages in the markets where they operate.

Source: by the authors (2022), from Barbieri et al. (2010, p. 150-151).

Barbieri et al. (2010, p. 150) distinguish two concepts of sustainable innovation: a traditional one, which implies only the introduction of technological novelties of product/service and process, management and business model so that the organization has its continuity extended indefinitely, as their social contracts suggest; and another that effectively contributes to sustainable development, in order to include, in addition to economic effects, the assessment of social and environmental impacts. Despite this, as the economic effects of innovation are much easier to predict,

> [...] what is most observed is the continuity of the conventional understanding accompanied by a discourse that incorporates the theme of sustainable development only at the level of good intentions, when it is not a means of appropriating an idea that is gaining importance for the population and opinion makers.

The article in question emphasizes the argument of strong sustainability, since, without losing sight of the importance of economic sustainability, it insists throughout the entire text on the need for attention to the social and environmental pillars. The authors point out that:

> The assessment of socio-environmental consequences must be part of the innovation processes and not just the economic assessment. It is common to find in texts on innovation management that the expectation of a negative or below-the-expectations economic result interrupts or redirects a specific innovation process. Project interruption or redirection should also occur with respect to negative or suboptimal social and environmental outcomes. (BARBIERI et al., 2010, p. 151-152).

And, although business initiatives for sustainable innovation can be observed, since they can distort the proposed concept of sustainability, or also because companies may not yet have the appropriate management instruments, "[...] teaching and research institutions, government bodies, standardization institutions, civil society organizations, that is, the national innovation system also plays a relevant role in this matter." (BARBIERI et al., 2010, p. 152).

According to the STEPS Center[10] (2010, p. 4-5), recognizing the decisive role of this larger set of institutions and interactions "[...] helps us abandon the simple model of technical progress in the name of accepting a wider range of interactions behind all kinds of innovation." However, it is still essential to shift the focus from the scale and pace of innovative activity to its direction, distribution or diversity, based on a series of questions:

> The first is about the technical, social and political directions for change: 'what are innovations for?'; 'what kinds of innovations, along which paths?' and 'towards what goals?' To seriously address these questions requires that we look much more closely at distribution issues. For any problem presented: 'who are the innovations for?'; 'whose innovations are considered?' and 'who wins and who loses?' This in turn raises additional questions about diversity: 'what – and how many – types of innovations do we need to solve a given challenge?'

These concerns, representative of "a new 3D agenda for innovations", contemplate the vision "[...] of a world in which science and technology work more directly for social justice, the reduction of poverty and the environment." (STEPS CENTER, 2010, p. 8).

In this world, STI policies, like any other, must have room for broad discussions, as:

> [...] it is no longer acceptable that politicians and business leaders impose the fostering of their own directions for innovation as somehow being the only ones 'based on science', 'pro-innovation', 'pro-development' or 'pro-technology'. (STEPS CENTER, 2010, p. 8).

Thus, there are several assumptions to be observed:

> This calls for innovations that have a transformative power – reshaping social and power relations to enable innovation in new directions. This means challenging the dominance of paths driven solely by private profit and military objectives. It means innovation for sustainability, paying special attention to ecological integrity, environmental diversity and social values. It means that the benefits of innovations are shared widely and equitably and not captured by narrow and powerful interests. It means encouraging open and plural forms of innovation pathways – social and technical, high-tech and low-tech; currently unknown paths, as well as those easily recognized. It means organizing innovations so that they are interconnected, distributed and inclusive, involving a diversity of people and groups, including the poor and marginalized. And it means reaching out to technical elites in large international, state and commercial organizations to support and harness the energy, creativity and inventiveness of users, workers, consumers, citizens, activists, farmers and small businesses.

In order to demonstrate how this world can become a reality, the STEPS Center (2010, p. 9-11) issued recommendations, organized into five sets of actions, which can be summarized as follows:

10 The STEPS Center (Social, Technological and Ecological Pathways to Sustainability) is an interdisciplinary research and global policy network that brings together development studies with scientific and technological studies. Established at the Institute of Development Studies and SPRU Science and Technology Policy Research at the University of Sussex, England, with partners in Africa, Asia and Latin America, it is funded by the Economic and Social Research Council.

1. Agenda setting: the debate for defining innovation priorities at national and international levels needs to include the voices of the poorest and most marginalized populations. At the national level, the creation of Strategic Innovation Forums is suggested, and, at the international level, a Global Commission on Innovations, under the protection of the UN and assuming responsibility for the most deprived communities in the world;
2. Financing: STI funding needs to address the challenges of poverty reduction, social justice and environmental sustainability. Therefore, STI funding agencies must ensure that a significant and growing proportion of their investments are directly focused on these challenges, as well as the government must provide incentives for the private sector to invest in forms of innovation created for this purpose;
3. Professional training: professional training in STI must expand its scope and also include other participants in the innovation system, including local entrepreneurs, citizen groups and small companies, as well as their users, segments of civil society and social movements;
4. Organizing: Organizing for innovation requires identifying and supporting social action plans and institutional programs that enable technologies to work in specific contexts and meet the needs of the poorest and most marginalized women and men. Thus, the legal implications, regulatory rules and investment priorities that arise from this policy should explicitly reflect such priorities, such as, for example, increasing support for public domain innovation platforms;
5. Monitoring, evaluation and accountability: in countries, and also on the global stage, indicators related to the priorities of poverty reduction, social justice and environmental sustainability should be defined and applied for monitoring innovation systems, taking the focus away from indicators such as publications, patents and aggregate levels of expenditure. In addition, the Strategic Innovations Forum should regularly and publicly report findings to national legislative chambers and the Global Commission on Innovations.

Based on the assumptions set out in this subsection, we can state that sustainability and innovation can coexist, and that very different concepts of sustainability can be connected with STI strategies. As seen, the easiest, most common and perhaps most attractive is the one that drives economic growth with or without limits, accompanied or not by the belief that it will bring, by itself, social development and environmental preservation.

As already highlighted in the previous section, this was the paradigm adopted by the Brazilian Innovation Law, which from its edition already had a French inspiration and, from the changes promoted by Law no. 13.243/2016, is considered equivalent to the legislation of countries such as the USA and Russia (GARGIONI, 2016).

In view of this, authors such as Fonseca (2017) and Oliveira (2012) propose the adoption of alternative ideas for innovation. The former highlights the importance of the so-called Social Technologies, characterized by citizens and users actively participating in their development and, therefore, being able to include social, ethical and environmental purposes. The latter defends a model of governance of rights arising from the protection of Intellectual Property that can replace the exclusive property model, extracted, for example, from the free software experience.

Seeking to investigate in depth whether there is room for the promotion of socio-environmental sustainability in the existing STI legislation, it is important to check edited documents based on it, such as the STI policy, referred to in articles 5[11] and 19, paragraph 1[12] of the Innovation Law. In turn, the regulation of this law until recently in force – Decree no. 5,563/2005 – again decided to relegate the discipline of STI policy to a hierarchically inferior norm, as provided for in its article 20, paragraph 1: the priorities of the national industrial and technological policy will be defined in a joint act of the Ministers of State for Science and Technology and for Development, Industry and Foreign Trade.

In this context, the then Ministry of Science, Technology and Innovation edited the National Strategy for Science, Technology and Innovation 2016-2019. The document is indeed impressive, with several passages related to social and environmental causes, including sections specifically dedicated to addressing the challenges of developing innovative solutions for productive and social inclusion and strengthening the bases for promoting sustainable development.

However, it is important to be aware that the document in question, although representing a strong commitment to society and establishes guidelines for control, does not prevent the implementation of the STI policy from following other parameters or focusing on just a few objectives. In this sense, Fonseca (2017, p. 124) identified that, in the government discourse implemented from 2003, the need to promote social technologies as an instrument of the country's social, economic and regional development is mentioned. However, despite the discourse, technology social policy has never actually been taken as public policy by the State.

11 Art. 5. The Union, and the other federative entities, and their entities, are authorized, under the terms of the regulation, to participate in a minority in the share capital of companies, with the purpose of developing innovative products or processes that are in accordance with the guidelines and priorities defined in science policies, technology, innovation and industrial development of each sphere of government.

12 Art 19. The Union, the States, the Federal District, the Municipalities, the ICTs and their development agencies will promote and encourage the research and development of innovative products, services and processes in Brazilian companies and in Brazilian non-profit entities governed by private law , through the concession of financial, human, material or infrastructure resources to be adjusted in specific instruments and destined to support research, development and innovation activities, to meet the priorities of national industrial and technological policies. Paragraph 1: The priorities of the national industrial and technological policy referred to in the caput of this article will be established in regulation.

Still in the text of the Innovation Law, it is recommended that a minimum of stimulus to sustainable development be identified in the interactions resulting from it. Pereira (2015), in the principle of decentralization of science, technology and innovation, sees activities in each sphere of government, with deconcentration in each federal entity (art. 1, sole paragraph, subparagraph IV) and, in encouraging the figure of the independent inventor (article 22), the author sees possibilities for greater dedication to research based on impact science, that is, research that increases understanding of the impacts of production processes and their externalities on the environment and human health.

In addition, it is possible to examine laws produced by other federal entities, in the use of concurrent competence to legislate on education, culture, teaching, sports, science, technology, research, development and innovation conferred by article 24, subparagraph IX of the Constitution of the Republic.

Eventually, these municipal or state laws may be more beneficial to society and the environment, not least because, according to paragraph 2 of the same article 24, the competence of the Union to legislate on general rules does not exclude the supplementary competence of the states, as well as subparagraphs V, VI and XII also establish concurrent legislative competence in matters of production and consumption, conservation and defense of natural resources, protection of the environment and control of pollution, protection and defense of health.

Innovation Law of Santa Catarina and the possible resumption of constitutional values

On January 15, 2008, the State of Santa Catarina edited Ordinary Law no. 14.328, which establishes incentive measures for scientific and technological research and innovation in the productive environment, aiming at the state's training in science, technology and innovation, regional balance and sustainable economic and social development.

The Law of Santa Catarina, in short, enables the formulation and evaluation of the STI policy by the CONCITI (State Council for Science, Technology and Innovation), chaired by the Governor and made up of representatives of the State Government, the business sector and educational and technical-scientific institutions; encourages public researchers and innovation activities in the state's STI institutions, the implementation of NITs, the participation of companies in technological innovation of public interest, the state's participation in investment funds in innovative companies or in loan guarantees, subject to prior authorization of the Legislative Assembly; consolidates the policy of technology parks incubators, aiming at new businesses, work, income

and competitiveness; and institutes the "Santa Catarina Innovation" Award.

One of the merits of this standard is that it provides for sustainable development as a primary aim. However, we observe that the provisions of the Santa Catarina Innovation Law do not bring greater references to sustainability, nor do they establish limits, requirements, goals or priorities for technological innovation in the State.

Another positive point in the Santa Catarina Innovation Law can also be seen in the fact that, as verified by Gonzatti and Pereira (2016), it is still not adapted to the new Brazilian STI legal framework, which deepened the privatist logic. However, as the author observes in her monographic work, such an approximation will have to be made insofar as, as provided in article 24, paragraph 4 of the Federal Constitution regarding concurrent legislative competence, the supervenience of a Federal Law on general norms suspends the effectiveness of the State Law in what is contrary to it.

In addition, Santa Catarina authorities who actively participated in the elaboration of the new Brazilian STI framework already signal their intention to provide for an updating of state legislation (SQUIO, 2011; GARGIONI, 2016).

However, starting from the premise that every law owes obedience to the Constitution, and that the applicator of the norm must also always be guided by the fulfillment of the assumptions established in the fundamental law, it is important to understand that, even though this was not expressly determined in the legal landmarks, its agents (companies, government and STI institutions) should promote research on the socio-environmental impacts of production, limit research aimed at increasing production, as well as develop research based on socio-environmentally sustainable technologies.

As indicated in the Santa Catarina Innovation Law itself, the development of technological innovation must respect the precepts of the State Constitution[13]. And Art. 177 of the Magna Carta of Santa Catarina determines that the scientific and technological policy will have the following principles: I - respect for life, human and environmental health and the cultural values of the people; II - the rational and non-predatory use of natural resources; III - recovery and preservation of the environment; IV - the participation of civil society and communities; V - the permanent incentive to the formation of human resources.

Therefore, the Brazilian STI legal framework offered innovation agents various instruments for economic development, while remaining silent about requirements capable of linking it to

13 Art. 1 This Law establishes incentive measures for scientific and technological research and innovation in the productive environment, aiming at training in science, technology and innovation, regional balance and sustainable economic and social development of the state, **in accordance with articles 176 and 177 of the Constitution of the State of Santa Catarina** (emphasis added).

socio-environmental sustainability. The Santa Catarina Law mentioned sustainable development, but without predicting how to achieve it.

However, care for the social pillar and the environmental base should not be forgotten. First, it is a logical conclusion arising from the premise that, without the biosphere, there is no humanity and, therefore, no economy. Also because the Federal Constitution inserts scientific and technological research and innovation in a context of promoting the public good and solving Brazilian problems (among which environmental degradation and social inequality stand out), as well as requiring everyone to defend and preserve an ecologically balanced environment for present and future generations. And finally, the Constitution of the State of Santa Catarina establishes principles that determine the adoption of socio-environmental criteria in science and technology policy.

This same guideline can be found also in the Universal Declaration of Human Rights, whose art. 27 provides that everyone has the right to freely participate in the cultural life of the community, to enjoy the arts and to take part in scientific advancement and its benefits.

Hence, if people have the right to enjoy the benefits of scientific progress, this cannot be dedicated solely to leveraging economic growth, once, as seen, this would cause numerous social and environmental damages.

> Innovation quickly became a scope for the most diverse segments of knowledge and seems to be increasingly encouraged by the media. There is no doubt about the benefits that all innovative modifications to products and processes can bring. Although the field for these transformations is very promising, little is questioned as to where the limits to operating the transformation stand, or if there are any limits to it. What has been noticed a great deal so far is a mere economic concern; there is a need, therefore, to review such measures and focus efforts on the recipients of innovations. (RODRIGUES; ENGELMANN, 2014, p. 224).

Pereira, Rodrigues and Oliveira (2015, p. 4-5) state that there is currently talk of a fourth helix in the innovation movement, represented by society, or even a fivefold helix, in which, in addition to government, universities and companies, investors and users would take part. In the same sense already proposed, the authors state that "[...] society or users [sic] share the community's sustainable needs, society's participation in innovations that generate impacts on quality of life [...]".

Approaches such as these point to the importance of not only financial investment in innovation, but also in communication.

The open innovation model, which is complementary to the triple helix model, points to the advantages of establishing a cooperative environment between companies themselves, in addition to partnerships between them and research institutions (FONTANELA, 2016, p. 60-71).

Castells (2006) identified this environment by noting that the trajectory of industrial revolutions began in England, but the second industrial revolution, more dependent on science, shifted its axis to the US and Germany.

> The reason for this lies in the territorial basis for the interaction of systems of discoveries and technological applications, that is, in the synergistic properties of what is known in the literature as 'means of innovation'. In fact, technological breakthroughs occurred in clusters, interacting with each other in a process of ever-increasing returns. Whatever the conditions that determined these clusters, the main lesson that remains is that technological innovation is not an isolated occurrence. It reflects a certain stage of knowledge; a specific institutional and industrial environment; a certain availability of talent to define a technical problem and solve it; an economic mindset to make this application cost-effective; and a network of manufacturers and users able to communicate their experiences cumulatively and learn by using and by doing. (CASTELLS, 2006, p. 73).

Castells' analysis highlights the importance of capital diversification for the development of innovation, as well as its sources. Money, infrastructure and notably knowledge come from various institutions and individuals involved in the process, including users of the new technology.

The protagonism of users is defended by Carayannis and Campbell (2009), formulators of the quadruple helix theory. The fourth helix, in the view of these authors, is represented by the public based on culture and media. The

> [...] plausibility for the explanatory potential of a fourth helix is that culture and values, on the one hand, and the way 'public reality' is being constructed and communicated by the media, on the other hand, influence all national innovation systems. (CARAYANNIS; CAMPBELL, 2009, p. 206, our translation).

This proposal emphasizes the democratic and plural nature of knowledge. By integrating the fourth helix, Carayannis and Campbell (2009, p. 218, our translation) state:

> We suggest that the advanced knowledge-based economy and advanced democracy have increasingly similar characteristics, in the sense of combining and integrating different modes of knowledge and different modes of politics.

In a recent publication, Carayannis and Grigoroudis (2016, p. 37) even state that "[...] the quadruple helix of innovation builds a bridge over social ecology with the production of knowledge [...] and innovation."

In this study, the authors give centrality to the public based on media and culture – now encompassed in the concept of civil society – in the development of innovation:

> This Quadruple Helix model puts innovation users at its heart and encourages the development of innovation that is relevant to

> users (civil society). Users or citizens in this context own and direct innovation processes. Arnkil et al. maintain that the degree of user involvement can be defined as inclusion of 'design by users' (Arnkil et al., 2010). According to this perspective, new products, services and innovative solutions are developed with the involvement of users who take the lead, as well as with co-developers and co-creators (Carayannis, 2001; Afonso et al., 2010). According to this model, citizens will not only be involved in current development work, but will also be empowered to propose new types of innovations, which then connect users with their stakeholders across industry, academia or government (Arnkil et al., 2010). In turn, the role of actors in the other three helices would be to support citizens in such innovation activities (for example, by providing tools, information, development forums and skills needed by users in their innovation activities). In addition, industrial agents and public sector stakeholders could then exploit innovations developed by citizens. (CARAYANNIS; GRIGOROUDIS, 2016, p. 37-38).

Leydesdorff, co-author of the triple helix theory, analyzing the different concepts attributed to the fourth helix – users, society, public, internationalization – recently argued that an exponential quantity or an alphabet of helices can be imagined, because "[...] a pluriform 'society' is no longer coordinated by a central instance (such as 'Rome' or 'Moscow'), but works in terms of interactions between codified communications in different ways." (LEYDESDORFF, 2012, p. 30).

For Rodrigues and Engelmann (2014, p. 236-237), this or these other propeller(s) represent the concern with the socio-environmental impacts of innovations. According to the authors, they must be designed from the principle of precaution and the principle of prevention, whose fusion generates the principle of "as low as reasonably possible", with the meaning that "[...] the harmful effects in relation to to the human being and the environment must be kept at a reasonably minimum level, evaluated from analysis methodologies constructed by the mediation between the Human Sciences and Exact Sciences."

Therefore, and considering the normative framework exposed here as the foundation for the regulation of technological innovation,

> [...] the 'quadruple helix' is proposed, with the addition of one more helix: that of Human Rights, which ethically sustains the movement of the other three helices, ensuring the necessary integration of innovation with concern for human beings and the environment. (ENGELMANN, 2010, p. 180).

The idea of respect for human rights in production processes is deeply rooted in the term socio-environmental sustainability, since any prospect of enjoying the rights of current and future generations requires a healthy and durable environment.

Precautionary Principle for STI

Until the mid-1980s, prevailing international legal instruments determined that environmental measures should follow the guidelines

of science. From then on, a more defensive position was adopted due to the possibility of scientific errors and the very absence of scientific production (RUIZ *apud* MACHADO, 2006, p. 72).

It is in the precautionary principle that "[...] the current and more generalized position that the law adopts in the face of scientific uncertainty is condensed." (PARDO, 2015, p. 169). The origin of this principle, still with a very limited content – guiding "[...] the action of public authorities in the sense that they should value and take into account the environmental implications that their decisions and actions may have [...]" –, occurred in the 1970s in Germany.

This was followed by the affirmation of the principle in international declarations such as that of Rio de Janeiro in 1992 and the consolidation in the jurisprudence of the European Union and the United States, soon after being appropriated by political discourse and public opinion (PARDO, 2015, p. 170).

The assumption of the precautionary principle is scientific uncertainty, as its function is precisely to decide when there is suspicion of dangerous effects to the environment and health. And the uncertainty can be original, when the application of the technique precedes the scientific knowledge about it, or supervening, when, after its implementation, the advance of scientific knowledge detects risks related to a technique that until then had not been identified (PARDO, 2015, p. 172-173).

Principle 15 of the Rio de Janeiro Declaration of 1992, mitigating the lack of scientific knowledge and emphasizing the need for environmental care, advocates that "[...] when there is a threat of serious or irreversible damage, the absence of absolute scientific certainty should not be used as a reason for postponing effective and cost-effective measures to prevent environmental degradation."

Two meanings operate on the precautionary principle: one that goes back to its beginning, in which precaution acts as a principle that precedes the elaboration of norms related to matters involving risk, and another more recent one, according to which it is applied directly at the moment of decision-making (PARDO, 2015, p. 171).

Evidencing the normative function of the principle in reference, Paragraph 1 of Art. 225 of the Federal Constitution imposes on the Government a series of obligations to ensure the effectiveness of the (fundamental) right to an ecologically balanced environment, among which stands out the control of production, commercialization and use of techniques, methods and substances that involve risk to life, quality of life and the environment (item V).

Despite its content and normative and decision-making effectiveness, the precautionary principle does not prevent the continuity of scientific investigation. On the contrary, the progress of science is necessary precisely so that precaution can be operationalized, as emphasized by Leite and Ayala (2004, p. 80):

> [...] contrary to what could be argued, the application of the precautionary principle does not produce a divorce from scientific activity, nor does it intend to overcome or replace investigation, but rather reinforces their importance, placing it as an approach for the protection of fundamental rights. In view of the lack of sufficient information available at the time when a decision on the product or activity is required, a double system of obligations is guided, which includes the obligation to investigate and the obligation to opt for the application of the most appropriate measures, in accordance with the elements presented by the conflict.

Machado (2006, p. 63) reinforces that "[...] the implementation of the precautionary principle does not intend to immobilize human activities. It is not a matter of the precaution that prevents everything or that sees catastrophe or evil in everything."

The application of the precautionary principle generates exception measures, so called because they make existing rules ineffective, as in determining the withdrawal of a product from the market that had complied with all the conditions imposed on it. As a result, according to European law, these measures must observe criteria of proportionality and be provisional, which, according to Pardo (2015, p. 173-174), will be determined by science itself.

Leite and Ayala (2004, p. 83-86) point out that the measures established in the Constitution regarding the right to the environment should not be seen as absolute values, since the precautionary principle is associated with levels of tolerability, and its application is an exercise of determining the acceptable level of risk for society. For the authors, this must be carried out from solid democratic bases, allowing information to be shared with society, rather than restricted to the scientific environment.

Effectiveness in applying the precautionary principle presupposes "[...] overcoming haste, precipitation, improvisation, senseless speed and the desire for immediate results [...]" (MACHADO, 2006, p. 75), for the "[...] identification and evaluation of the integrality of the assets and values involved in the weighing process." (LEITE; AYALA, 2004, p. 92).

For Derani (2001, p. 172), the objective of precaution should be more rigorous, because, instead of guiding the assessment of the risks of doing something, "[...] the general criterion for carrying out a certain activity would be their 'necessity' from the point of view of improving and not harming quality of life."

On the other hand, the principle is also criticized for its paralyzing effect, being accepted by a portion of scholars only in a weak conception.

In this sense, Sustein (2012, p. 28) identifies the strong meaning of precaution "[...] as determining that regulation will be necessary whenever there is a possible risk to health, safety or the environment,

even if the elements' evidence are speculative and the economic costs of regulation are high."

However, he defends a weak precautionary model, which would be applicable as follows:

> For a weak version, the main task is to find ways to match the length of the proof with the length of the answer. Weak evidence of the risk of harm, for example, may support the need for further study of the issue, while slightly stronger evidence may justify publicly disclosing the risk, and even stronger evidence may support the adoption of regulatory controls. (SUSTEIN, 2012, p. 28).

Encouraging technological innovation is a field in which the precautionary principle should be intently observed, because, although there is a current consensus on the need for innovation for economic sustainability, the immeasurable adventure to conquer new success formulas makes uncertainty the engine of a vicious process, given that an economic settlement can be linked to an infinity of abstract or concrete socio-environmental risks.

This principle, in a more agressive vision, can be understood as the need to avoid the insertion of any element in the market or even in the social environment when there is doubt about its potential to cause serious environmental damage, and this doubt can be dissolved through the deepening of the scientific investigation, thus allowing the distribution of the product or activity.

Under a weak perspective, precaution acquires different degrees of application, in proportion to the level of evidence produced concerning the risk.

The production mill theory, exposed in the previous chapter, indicates that there is a preference for production science in academic and political circles, and, obviously, in the business sphere. This was the model incorporated by the Brazilian STI legal framework, as discussed in this chapter.

There is no express provision for instruments to promote socio-environmental sustainability in the aforementioned legal framework. However, based on a strong concept of sustainability and the fundamental norms that support the infraconstitutional regulation of the STI – including the precautionary principle –, even so, measures capable of curbing the pursuit of pure economic growth, regardless of its possible harmful consequences for society and the environment, must be taken.

Conclusion

The importance attributed to innovation today has led to the establishment of laws aimed at promoting a dynamic interaction between companies, government and research institutions, the so-called triple helix.

Economic criteria are the basis of the Brazilian STI legal framework, which, at first sight, seem to overrule any ecological concerns. Still, what guided the formulation of the normative structure of STI in the country – which even includes a Constitutional Amendment edited with the purpose of substantiating the actions articulated between academia and the productive sector – was an almost magical idea that economic expansion would reduce social problems.

On the other hand, reading the Constitution of the Federative Republic of Brazil leaves no doubt that a balanced environment is a fundamental right, a prerequisite for the realization of human dignity. The constitutional text subordinates scientific development and innovation to the public interest, as well as the economic order to the defense of the environment and the reduction of regional and social inequalities.

Therefore, the Brazilian STI legal framework must be interpreted in a way to reflect this concern, establishing instruments to promote strong socio-environmental sustainability.

When faced with the Santa Catarina Innovation Law , it appears that it expressly provides for sustainable development as an objective, and ties innovation to the dictates of the State Constitution that support scientific and technological policy in respect for life, human and environmental health and the cultural values of the people, in the rational and non-predatory use of natural resources, in the recovery and preservation of the environment, in the participation of civil society and communities and in the permanent incentive to the formation of human resources. However, the State Law does not present commands specifically directed to these ends.

It can therefore be said that both federal and state legislation on STI require hermeneutic strategies that lead to the development of technologies capable of increasing environmental conservation and the fair distribution of economic gains.

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The constitutionalization of innovation in Brazil

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Introduction

The knowledge society[1], which succeeds and is supported by the constructions of the information or network society, determined by Castells (1999) at the end of the last century, has its central concept precisely in innovation[2]. This term was quickly appropriated by the (knowledge) economy, which converts innovation from a public good, related to the social ingenuity of the knowledge society, into a private good[3] (BUFFON, 2019). Especially because the knowledge economy, based on innovation, "[...] does not intend to be just another source of producing goods and services under typical arrangements of equipment and technologies, but proposes to be a production paradigm that continually reinvents itself." [4] (UNGER, 2018, p. 26).

However, at the same time, despite the association of technologies to the private sphere, the innovation process has been increasingly collective, with the participation of all actors in society. Or rather, as Mazzucato (2014, p. 243) points out, in the innovation process, "[...] taking risks has increasingly been the result of a collective effort – with the State playing a leading role in the system of ' open innovation' –, while the fruits have been distributed less collectively [...]", referring

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1 Despite Terán Cano (2018, p. 147) mentioning that "[...] the notion of societal knowledge has its origins in the 1960s when the behavior of industrial societies was studied and, from then on, the notion of the post-industrial society began to be considered with the active presence of a new social layer of workers who were heading towards a society of knowledge. This type of society is characterized by an economic and social structure, in which knowledge has replaced work, raw materials and capital as the most important source of productivity, growth and social inequalities."

2 Spinosa, Krama and Hardt (2018, p. 194) refer to this in the same sense, stating that "[...] the knowledge economy advocates the need to generate, disseminate and use knowledge in modern economies; a global phenomenon that holds that knowledge has become the driving force for economic growth and social development, largely based on the promotion of innovations."

3 An appropriation that is clear in authors such as, for example, Etzkowitz (2009, p. 5), who states that "[...] innovation, the reconfiguration of elements in a more productive combination, takes on an even broader meaning in increasingly knowledge-based societies."

4 In addition, Carvalho (2020, p. 105) states that "[...] innovations play a relevant role in the process of economic growth both in theories that are still part of the mainstream, such as the models of the New Theory of Growth, and in evolutionary and complexity economics approaches."

to the prominence given to companies in the capitalization of technologies.

Despite the criticism, nations have invested in public policies to encourage innovation. In Brazil, it is no different. Especially in the 21st century, the promotion of innovation has gained prominence in government agendas, with the enactment of laws, programs and strategies for the development of innovation in the country. Public guidelines and policies, aim to create a systemic movement to support innovation beyond the public sector, also reaching the private sector.

In this sense, this chapter starts from the observation of the reality of the innovation scenario in Brazil. In this macro context, the promotion of innovation is evaluated, carrying out an analysis of the constitutionalization of innovation in Brazil.

The symbolic value of innovation in the Constitution

Before entering federal and state legislation, it is essential to pay close attention to the constitutionalization of innovation in Brazil to identify the constitutional basis[5] of this normative set, that is, the matrix that configured the current legal framework for innovation. Especially because, as expected, the Federal Constitution is the basis for any legal study. Here, it will be no different, as the central theme of the work – innovation – is also addressed in the constitutional text, signaling its relevance for Brazilian society. As Santos and Silva (2018) indicate, technology and innovation are fundamental and indispensable means for the scientific progress of a country, and with the constitutionalization of science, technology and innovation, Brazil is in search of instruments to produce technological innovations in a competitive manner.

The Federal Innovation Law[6], the main legislative instrument of the Brazilian innovation framework, helps to identify the constitutional matrix, as it evidences, in its Art. 1, that:

5 Santos e Silva (2018, p. 130), with the purpose of clarifying the main constitutional provisions in relation to STI, present an interesting study with the provisions of the respective historical Constitutions of Brazil: CF/1824 – Missing; CF/1891 – Missing; CF/1934 – Missing; CF/1937 – Art. 128 – Art, science and teaching thereof are open to individual initiative and that of associations or collective persons, public and private. It is the duty of the State to contribute, directly and indirectly, to the stimulation and development of both, favoring or founding artistic, scientific and teaching institutions; CF/1946 – Art. 173. The sciences, letters and arts are free. Art. 174. Supporting culture is a duty of the State. Sole paragraph: The law will promote the creation of research institutes, preferably together with higher education establishments; CF/1967 – Art. 171 – The sciences, letters and arts are free. Sole paragraph: The public authorities shall encourage scientific and technological research; CF/1969 – Art. 179. The sciences, letters and arts are free, except for the provisions of paragraph 8 of art. 153. Sole paragraph: The public authorities shall encourage scientific and technological research and teaching.

6 Law no. 10.973, of December 2, 2004, which, according to Carlotto (2013, p. 108), "[...] is the most important piece of the legal-institutional reform of the national scientific system underway in the country, which began in the second mandate of President Fernando Henrique Cardoso, since Ambassador Ronaldo Sardenberg took over the Ministry of Science and Technology (MCT) (1999 to 2002). Proposed at the Second National Conference on Science, Technology and Innovation, in 2001, and later placed in public consultation by the MCT, the law would only be approved

> [...] this Law establishes measures to encourage innovation and scientific and technological research in the productive environment, with a view to technological training, the achievement of technological autonomy and the development of the country's national and regional productive system, pursuant to articles 23, 24, 167, 200, 213, 218, 219 and 219-A of the Federal Constitution.

It is important to note that, from the set of articles cited by ordinary legislation, articles 218, 219, 219-A and 219-B make up Chapter IV – On Science, Technology and Innovation, which is part of Title VIII – On the Social Order, from the Federal Constitution. In this sense, it is worth highlighting the sensitivity of the constitutional legislator, emphasizing the theme of "science and technology", since the conception of the Federal Constitution in 1988[7], as well as the incorporation of the terminology "innovation", which becomes part of the text from the Constitutional Amendment n. 85, of 2015[8].

As Molinaro and Sarlet (2012, p. 16) indicate, one of the fields designed by law and amalgamated in the Constitution, as a dynamic architecture structured to meet, among others, socio-political demands and socio-cultural and economic needs, concerns scientific development, dedication to research and the promotion of technological capacity. According to the authors, the constituent legislator's project was ambitious, as it brought together: i) one objective – scientific development; ii) freedom – dedication to research; iii) a procedure – technological training.

Regarding Constitutional Amendment no. 85/2015, due to the adjustments made, at first, it appears that it meets its initial proposal – PEC no. 290/13 –, which was to update the treatment of science, technology and innovation activities. This is a strategic and necessary movement for the development of the country, for, as Peck (2018) points out, society as a whole is undergoing a major change dictated by the digital revolution, which causes the need for a greater commitment on the part of the State to foster investment in the social, economic and technological development of the country. In this sense, the main line to

in December 2004, in the second year of Luís Inácio Lula da Silva's mandate. In this sense, it is possible to say, therefore, that the 'discourse of innovation' is one of the points of continuity between the two governments – formed by parties whose ideals are not only different, but, in many points, opposite –, which makes the understanding of the dynamics of its social production an even more interesting problem."

7 In the current Constitution, STI, for the first time in the history of Brazilian Constitutional Law, appears in a special chapter dedicated to the social order, in Chapter IV of Title VIII. The Constitutional Charter gave a new perspective to the matter, seeking to expand its regulation, presenting it in a separate and proper chapter, unlike that found in previous Constitutions, which treated the matter as science, letters and arts (SANTOS; SILVA, 2018, p. 131).

8 Constitutional Amendment no. 85 originates with the Proposal for Constitutional Amendment no. 290/13, which aims to amend and add provisions to the Federal Constitution to update the treatment of science, technology and innovation activities. The focus of the proposal can be summarized in three aspects: 1) stimulus to science, technology and innovation activities; 2) stimulus for the articulation of a scientific partnership between the public and private sectors; 3) flexibility of the researcher's activity in companies. The proposal, inserted in the Magna Carta, seeks to insert, with the support of the constitutional force, a needed reality in the Brazilian socioeconomic context. Support for scientific and technological research, as a means of achieving high rates of innovation, as mentioned above, is a precondition for the economic and social development of any nation at home or abroad.

dictate progress, according to the author, is the capacity for innovation. Therefore, Constitutional Amendment no. 85/2015 inserted the term "innovation" in the constitutional text, in art. 218, as well as support for technological extension.

The symbology of incorporating[9] the theme "innovation" in the constitutional wording opens up the possibility of new discussions, which may reverberate in public policies and help in the development of Brazilian society. An example that can be cited is digital inclusion, which is a challenge and, at the same time, a necessity for Brazilian society in the context of the knowledge era[10]. According to Ribeiro (2011, p. 3), digital inclusion must be seen from an ethical point of view, being considered an action that will promote the achievement of "digital citizenship", which will contribute to a more egalitarian society, with the expectation of social inclusion. The author understands that digital inclusion is access to information that is in the digital media and, as a point of arrival, the assimilation of information and its re-elaboration into new knowledge, with the desirable consequence of improving people's quality of life. However, it is essential to understand that, without encouragement from the State, discussions such as digital inclusion will hardly be accessible to Brazilian society or will promote national development.

It is important to note that, when exploring the theme in the context of the 1988 Constitution, one has the horizon of meaning of Science, Technology and Innovation. That is, according to Gadamer (2002, p. 456), the concept of horizon becomes interesting here, because it expresses the broader superior view that this understanding must have. For the author, gaining a horizon always means learning to see beyond what is close and what is very close, not to remove it from view, but precisely to see it better, integrating it into a greater whole and in more correct standards. Therefore, innovation, explored in the constitutional context, opens spaces on the horizon to explore the theme. Prete (2018, p. 93) confirms that the creation of the aforementioned constitutional amendment had, as one of its objectives, precisely to provide a constitutional "umbrella" for a set of rules that already existed at the time, as well as a unitary parameter for legislation that will still emerge for the implementation of the broad national STI policy.

9 Some scholars, such as Barbosa (2015), at the time of the publication of Constitutional Amendment no. 85/2015, believed that most of the amendments would not have a great practical effect and that the introduction in the constitutional text of the expression "innovation" showed sensitivity to terminological fads, but not necessarily attention to the needs of public policy. Barbosa's pessimism must be based on Brazilian history, since, as Veronese (2009) points out, constitutional texts represent examples of what was happening in the country's political practice: the difficulty of institutionalizing science and technology in Brazil.

10 Societies, according to the way they produced value, evolved as follows: a) extractive societies, through artisanal fishing and hunting, and in small groups; b) agricultural societies, with land, slave labor and capital as productive factors; c) industrial society, use of machines, bureaucratic organization, division of labor, standardization, routine, bureaucratic administration, and production of manufactured goods; d) information society, through the use of information networks, with the end of physical borders, global market formation and demands for debureaucratization; e) knowledge society, with a predominance of networked structures, intellectual capital, research, innovation, intangibles and information and debureaucratic management (PEREGRINO, 2018, p. 7).

The constitutional basis of science, technology and innovation

Bearing in mind the horizon of meaning of the chapter that defends the theme of science, technology and innovation, we enter into the specific analysis of the constitutional text. Starting with its article 218, head paragraph (*caput*), which establishes that the responsibility of the State (Union, States, Federal District and Municipalities[11]) is the promotion and encouragement of scientific development, research, scientific and technological training and innovation. As highlighted by Veronese (2009), the provisions of the articles in the chapter presuppose the operation of a complex, specialized system of action by the federal State, that is, the Union, the states and the municipalities, in addition to its relationship with companies and with organized society.

The head paragraph of article 218, according to Marques (2018) is the main norm of Chapter IV of Title III, dedicated – for the first time in Brazilian constitutional history – only to Science and Technology, and imposes a strong and clear constitutional guideline on the promotional function of the State in relation to scientific development, research in general and technological training. According to the author, it is an [active] duty of the State in general, a positive task of the State (guideline binding the State-Legislator, State-Executive and State-Judge) or a [legislative] competence of the State (art. 218 in combination with article 23, V, of CF/88, binding the legislative acts of the State) of "promoting" and "encouraging" science and technology[12].

The article also highlights the incorporation of the classic division of research into scientific and technological[13], recognizing the horizon perspective brought by Gadamer (2002). These concepts are developed in paragraphs 1 and 2 of Article 218. Currently,

11 Likewise, article 23, V, of the Federal Constitution, establishes: "Art. 23. It is the common competence of the Union, the States, the Federal District and the Municipalities: [...] V – to provide the means of access to culture, education, science, technology, research and innovation." Still, art. 24, IX, states: "Art. 24. It is incumbent upon the Union, the States and the Federal District to legislate concurrently on: [...] IX - education, culture, teaching, sports, science, technology, research, development and innovation."

12 "It is the eminent Minister Ellen Gracie, of the Federal Supreme Court, who clarifies, in a vote in ADI (Direct Action of Unconstitutionality) 3.510/DF, that it is a 'State duty... to promote and encourage scientific development, research and technological training (art. 218, head paragraph)'. In the view of the Federal Supreme Court, it seems to impose on art. 218 again a task that is the duty of the State. Article 23, V, mentioned above, is also in this sense. Constitutionalists claim that it is a social right (in the subjective dimension) and a duty-function or task of the State (in the objective and institutional dimension)." (MARQUES, 2018, p. 2082).

13 "Basic scientific research would be that which does not have direct economic and social applicability (to give an example, the research of a physical material, such as silicon, or of the genome), but which is necessary to support other research, these with applicability or economic possibilities and to transform it into technology (for example, computer chips, in which silicon is the basis for data transmission); therefore, the 'first' and basic scientific research is the basis for the others, as, in the case of the chip and computer revolution, it is silicon." (MARQUES, 2018, p. 2089). "Technological research is applied research, with a view to producing knowledge for practical use, whether of a direct economic nature, as an input for economic development, such as knowledge that determines the technical improvement of certain productive activities, as well as any application that, even without an application from which direct economic advantage results, implies improvement or perfectioning of knowledge of practical application in any field of technique and is closely linked to intellectual property." (MARQUES, 2018, p. 2092).

technological research also receives priority treatment, with both basic and technological research focusing on the public good and the progress of science, technology and innovation. According to Barbosa's understanding (2011), sharing the burden of knowledge production makes research non-appropriable, whether by private economic agents or by national agents. This knowledge, in principle, is produced for human society as a whole, and for the public good[14] in general. Marques (2018) also clarifies that the priority treatment that should be given by the State, with a view to the public good and the progress of science, does not mean a hierarchy in degrees of importance, in society, of basic research in relation to technological research, but rather as complementary planes of knowledge production.

However, Paragraph 2 of Art. 218 continues to endorse the State's duty to appropriate technology generated with taxpayer funds. In technological research, as determined by the constitutional norm, state investments must be destined to solve Brazilian problems. Here, research will not be free[15], as in scientific production. In addition to directing resources to solve Brazilian problems, the Constitution also elects the recipient of resources, that is, the regional and national productive sector.

Hence, as highlighted by Veronese (2009), technological research depends greatly on institutional arrangements with society ("Brazilian problems") and with the productive sector. The author also mentions that, unlike scientific research, technological research is easily justified by common sense, and the appropriation of new technologies for social development clearly demonstrates and justifies its existence and expansion.

After science and technology, article 218, in its third paragraph, mentions the aspect of training, noting that the State will support

14 "However, the advancement of scientific theory, related to the notion of 'basic research', included in the wording of the Federal Constitution of 1988, is not subject to protection. It is considered a part of the universal public good and is, in the case of Brazilian law, expressly excluded from its incidence of protection, in the form of a 'scientific discovery or theory'. What is called 'applied research' or 'technological research', also included in the current text, refers to the advancement of technology and may be supported by Industrial Property Law. In this sense, this second type of advance derives from human creations (inventions), whose protection has been requested and, moreover, its protection has been deferred as a property right." (VERONESE, 2009, p. 2308). In the same sense, Piaia (2009, p. 254) states that "[...] research aimed at meeting the economic and social development projected by the Federal Constitution goes beyond innovation and technological growth, and must meet local and regional conditions and potentials, even if they are a part of a policy of Brazilian society. This interaction must integrate public policies produced democratically in public spaces in order to bring about the expected changes in the economic, social and cultural spheres. Thus, the qualitative objectives of social/technological development and economic growth will complement each other to achieve the quality of life projected and desired by Brazilian society."

15 According to Barbosa (2006), previous Constitutions provided for freedom of science and the State's duty to support research, but the current text is the most extensive in history in dealing with the subject, despite not reiterating the principle of freedom of search. In the same sense, Marques (2018, p. 2072) says that: "[...] if several Brazilian Constitutions included science and technology in their normative-constitutional program, prioritizing, in most cases, the aspect of science as personal freedom or subjective right (freedom of research, expression, thought) and not as a task-duty of the State, it is in the current Constitution of 1988 that, for the first time, a chapter appears (Chapter IV of Title VIII – On the social order) dedicated to Science and Technology."

the training of human resources in the areas of science, research, technology and innovation, including through support for activities of technological extension, with the concession, to those who are in charge of them, of means and special working conditions[16]. In addition, paragraph 4 of article 218 indicates the law's support for companies that pursue the same objective, stating that:

> [...] the law will support and encourage companies that invest in research, the creation of technology suitable for the country, training and improvement of their human resources and that practice remuneration systems unrelated to salary, that ensure the employee participation in economic gains resulting from the productivity of their work.

Commenting on the respective fourth paragraph, Marques (2018) believes that the implementation of this guideline implies reforms in teaching, so that professional education is structured at all levels of schooling, whether technical, higher or postgraduate, with the integration of different types of training: formal, acquired in specialized institutions; and non-formal, acquired through different means, including at work.

Subsequently, paragraph 5 of article 218 authorizes the specific allocation, for scientific and technological research, of budget revenues from the federal states and the Federal District, ensuring an exception to the prohibition provided for in art. 167, IV, of the Federal Constitution.

Finally, Constitutional Amendment no. 85/2015, also included paragraphs 6 and 7 to article 218, which aim to stimulate the articulation between public and private entities with the objective of promoting the the country's development, through research and innovation, and to encourage the activities abroad of the public institutions of science, technology and innovation.

In the current constitutional text, there is no longer a distinction between the purposes of scientific development, on the one hand, and the purposes of research and technological training, on the other hand. As mentioned by Barbosa (2015), Constitutional Amendment no. 85/2015, in its dazzling essay on harmlessness, merely altered the relationship between the correlative interests of science and technology, blurring the limits between science (which in 1988 should remain in the public domain for everyone's fruition) and technology, which originally was the appropriable element.

Finally, this modality of development, as mentioned by Barbosa (2011), is based on one of the fundamental objectives, provided for

16 The 85th Amendment did not appear to be concerned with the status of the inventor-worker. It did not change anything, let alone perfect the relevant constitutional regime (BARBOSA, 2015, p. 25).

in subparagraph II of article 3 of the CF/88, which aims precisely at "guaranteeing national development"[17].

In the same sense, Molinaro and Sarlet (2012, p. 16) state that Chapter IV of the 1998 Charter affirms a fundamental duty of the State: that of promoting science and technology, since its fulfillment is a condition for the fulfillment of one of the objectives of the Brazilian Republic, as announced in item II, of art. 3rd, that is, to guarantee national development[18].

In analyzing the Brazilian constitutional proposal, Barbosa (2011) questions whether such a right would be one of those fundamental third-generation rights, enshrined even internationally as a human right[19]. The author also states that the topic is thorny, especially at the international level, regarding the definition of what "development"[20] would be – "[...] simple economic growth or effective maturation of the beneficiaries of this human right?" (BARBOSA, 2011, p. 12).

In Brazil, as Barbosa (2011) confirms, there seems to be no doubt, as the right to national development is one of the indicators that the Federal Constitution offers as legitimizing elements of certain public postures in the field of scientific and technological research. Bortolanza and Boff (2012, p. 22) also ratify this understanding, referring that, in view of the direction that contemporary society is taking, based on capitalism and with all this technological development, a form of legitimizing technological development rights is created

17 "The basis of this constitutional principle of scientific development (a specific principle with regard to Science as a task of the State) is precisely the norm of art. 3, II, of CF/1988." (MARQUES, 2018, p. 2082). The right to national development imposes itself as a constitutional legal norm, of a fundamental nature, provided with immediate and imposing effectiveness over all the powers of the Union that, in this direction, cannot avoid acting, within their respective spheres of competence, in the direction of the implementation of actions and measures, of a political, legal or radiating nature, that aim at achieving that fundamental objective (SILVA, 2004, p. 67).

18 In fact, as Pinheiro-Machado (2011, p. 312) specifies, "[...] it is important to point out that the academic, industrial and legal environments now realize that without technological, scientific and innovative development there is no economic and social development."

19 It is possible to find in the 1993 Vienna Declaration and Program of Action: [...] 10. The World Conference on Human Rights reaffirms the right to development, as established in the Declaration on the Right to Development, as a universal and inalienable right and an integral part of fundamental human rights. As established in the Declaration on the Right to Development, the human person is the central subject of development. While development facilitates the enjoyment of all human rights, the lack of development cannot be invoked to justify the limitation of internationally recognized human rights. States must cooperate with each other to ensure development and remove obstacles that may be placed against it. The international community should promote effective international cooperation with a view to realizing the right to development and removing obstacles to development. Lasting progress in fulfilling the right to development requires effective development policies at the national level, as well as equitable economic relations and a favorable economic environment at the international level (UNITED NATIONS, 1993).

20 "There is no consensus among social scientists about the meaning of the term 'development', often confused with economic growth. Amartya Sen defines development as the process of expanding the ability of individuals to have options, to make choices. Relativizing material factors and economic indicators broadens the social and cultural horizons of people's lives. The material base of the development process is fundamental, but it must be considered as a means and not as an end in itself. Economic and social development is something broader than growth and concerns more qualitative than quantitative aspects. It is a manageable mechanism to improve the economic and social well-being of the population. A developed economy has competence to produce and, consequently, growth factors will increase its productivity." (PLAZA, 2011, p. 668).

in Law, that is, society needs contemporary law to be prepared to absorb and encourage such development. According to the authors, with transformations in the way humans live and the need for growth that society currently demands, the Law cannot remain inert to this, and must create mechanisms to grow at the same level as more developed countries. And this will happen with good public policies for technological growth, both in the public and private sectors.

Still, in relation to the guarantee of national development, in the technological area, item XXIX of art. 5 of the Federal Constitution, establishes that:

> [...] the law will ensure to the authors of industrial inventions temporary privilege for their use, as well as protection for industrial creations, the ownership of trademarks, company names and other distinctive signs, with a view to social interest and the country's technological and economic development. (BRASIL, 1988, [s.p.]).

In this sense, the Federal Constitution determines that the ordinary legislator, when regulating industrial property, respect the specific objectives mentioned in Subparagraph XXIX of Art. 5 – to aim at the country's social interest, favor the country's technological development and favor the country's economic development. As Barbosa (2011, p. 14) points out, this triad of objectives is necessary and must be balanced, and social interest, technological and economic development must be equally satisfied.[21]

In the same line of protection of industrial property referred to in Art. 5, Subparagraph XXIX, article 218 of the Federal Constitution also presents the need for a proper balance of simultaneous objectives, when it refers, in its second paragraph, to technological research necessarily focusing on the solution of Brazilian problems and the development of the national and regional production system. Thus, the legislation referring to research, created from the constitutional matrix of article 218, must necessarily contemplate the constitutionally required objectives, directing research and innovations towards the solution of Brazilian problems and seeking the development of the national and regional productive system.

Moving forward in the analysis of the constitutional text, article 219 follows a similar path to the previous article, establishing that the internal market is part of the national heritage and that this will be encouraged in order to enable cultural and socioeconomic development, the well-being of the population and technology autonomy in the country.

21 It is unconstitutional, for example, for a law or regulatory rule that, opting for a frankly exporting model, renounces technological development in favor of the complete acquisition of the necessary techniques abroad; or a law that, under the pretext of giving unrestricted access to technologies to the people, would eliminate any form of protection for national technological development (BARBOSA, 2011, p. 14).

In this article, as highlighted by Veronese (2009), the notion of market is conceptually inserted within the notion of society and directly intertwined with scientific and technological production. Thus, the author points out that the market[22] is understood as a relevant element for the functioning of social life, not being understood autonomously in relation to the needs of Brazilian society. Such a conception is compatible with a third-generation constitutional text, where the attempt to democratize not only the State, but private and commercial life, is evident.

In a similar sense, Cabral (2012) indicates that article 219 is even more forceful when it defines that the priority radius of action of national technological production must be "the internal market", through the search for "the country's technological autonomy". The author understands that there is a clearly Furtadian influence in this article, as the "domestic market" is seen as an instrument to promote development in a broader sense than the purely economic, presenting challenges to the "domestic market" like "cultural development", "a population's well-being" and "technological autonomy".

However, some authors, such as Silva (2007), claim that the rule in Article 219 should be among the provisions of the economic order, where it would fit best. The author understands that it would be a rule of an economic order rather than one of science and technology, in which the intervention of the economic domain finds an important basis for the control of the internal market.

In fact, as Natalino Irti states, regulating the market is always a political decision-making act, even if its instrument is a constitutional or infraconstitutional norm. The market, as stated by the Federal Supreme Court, in ADI 3512[23], "is a legal institution", "is not spontaneous", is a

22 Oliveira (2013, p. 1689) states that article 219 is principled and has an elastic content. This is because economists find it difficult to define what a market is. There is a consumer market, there is a savings market, there is an art market, there is a talent market, there is a labor market, as there are varied markets. Strictly speaking, it is to be presumed that the constituent intended to refer to markets of economic density, that is, those related to the production, circulation and consumption of goods, which, strictly speaking, are those that generate resources to finance development and support not only the service-providing State, but the power holders themselves. It is this resource-generating market that is considered a national heritage, notwithstanding the non-generating or low-resource-generating market, which is of an eminently cultural nature, and is relevant to determine the civilizational level of a people.

23 ADI 3512 was guided by the discussion of state intervention in free enterprise. Below is an excerpt from its menu: DIRECT ACTION FOR UNCONSTITUTIONALITY. LAW N. 7.737/2004, OF THE STATE OF ESPÍRITO SANTO. HALF PRICE GUARANTEE FOR REGULAR BLOOD DONORS. ACCESS TO PUBLIC PLACES OF CULTURE, SPORTS AND LEISURE. COMPETITIVE JURISDICTION BETWEEN THE UNION, MEMBER STATES AND THE FEDERAL DISTRICT TO LEGISLATE ECONOMIC LAW. CONTROL OF BLOOD DONATIONS AND PROOF OF REGULARITY. STATE SECRETARY OF HEALTH. CONSTITUTIONALITY. FREE INITIATIVE AND ECONOMIC ORDER. MARKET. STATE INTERVENTION IN THE ECONOMY. ARTICLES 1, 3, 170 AND 199, PARAGRAPH 4 OF THE BRAZILIAN CONSTITUTION. 1. It is true that the economic order in the 1988 Constitution defines an option for a system in which free enterprise plays a primordial role. This circumstance does not legitimize, however, the assertion that the State will only intervene in the economy in exceptional situations. Quite the contrary. 2. More than a simple instrument of government, our Constitution sets out guidelines, programs and purposes to be carried out by the State and society. It postulates a normative global action plan for the State and for society, informed by the precepts conveyed by its articles 1, 3 and 170. 3. Free initiative is an expression of freedom entitled not only by the company, but also by work. That is why the Constitution, when contemplating it, also considers "State initiative"; therefore, it does not privilege it as a good that belongs only to the company. 4.

"locus artificialis" of exchanges and agents to be regulated (MARQUES, 2018, p. 2110).

Regardless of the location of the text, the encouragement and focus on the internal market by the State are fundamental. According to Peck (2018), it is necessary to understand the sense of urgency applied to this matter, since Brazil is included in the list of developing countries that still have a great dependence[24] on agricultural economic assets[25] and that need to invest more in strengthening the development of the industry itself, especially in new sectors of the economy that can contribute to the production of a new model of wealth based on intellectual assets and the new digital economy.

Evolving in the analysis of article 219 is its sole paragraph, which, as mentioned by Barbosa (2015, [s.p.]), strengthens the state mission of STI, stating that:

> [...] the State will stimulate the formation and strengthening of innovation in companies, as well as in other entities, public or private, the constitution and maintenance of parks and technological centers and other environments that promote innovation, the performance of inventors and the creation, absorption, diffusion and transfer of technology.

In this sense, it is possible to locate the constitutional basis of the State's incentive for the formation of innovation spaces, the focus of this study. The constitution, from the state point of view, provides for the formation and strengthening of innovation with the following actors: a) in the public entities themselves; b) in companies and private entities; and c) with independent inventors. The text also mentions the incentive to create two specific spaces for innovation, technological parks and poles, and generalizes enabling the incentive to other environments that promote innovation.

According to Mata and Cordeiro (2018, p. 129), although innovation always occurs in an environment of uncertainty, intensive and extensive knowledge of the innovation ecosystem helps to minimize this uncertainty and the risks associated with it and, thus, the training of those involved should be a prominent issue in such environments.

The Constitution of Brazil, in its article 199, Paragraph 4, prohibits all types of commercialization of blood, however it establishes that the infraconstitutional law will provide for the conditions and requirements that facilitate the collection of blood. 5. The state normative act does not determine a financial reward for donation or encourages the sale of blood. 6. In the composition between the principle of free initiative and the right to life, the interest of the community, the primary public interest, must be preserved. 7. Direct action of unconstitutionality dismissed.

24 It is fundamental to position the country at this moment, because, as Grau (2007, p. 265) teaches, "[...] it is necessary to emphasize that the situation of each society in the face of technological challenge – a situation of autonomy or dependence – is that there is a need to determine its role, as subject or object, in the international market."

25 According to a preview of the 2021 Report on Commodity Dependence, from the United Nations Conference on Trade and Development (Unctad), Brazil is more dependent on commodities. In ten years, the share of basic products in exports rose from 56.5% to 66.6%. In the report, Unctad defends technology and innovation to help emerging countries overcome dependence on commodities. The proposal is that with these instruments, these nations can diversify their economies and escape the trap of dependence on commodities (MOREIRA, 2021).

Article 219, based on Constitutional Amendment no. 85/2015, was also complemented by articles 2019-A and 2019-B. It should be noted that article 219-A simply gives a constitutional aspect to what was already in article 19 of the Innovation Law, that is, assuring federal entities the condition of signing instruments of cooperation with public bodies and entities and with private entities, even to share specialized human resources and installed capacity, to carry out research projects, in scientific and technological development and innovation. And article 219-B[26] instituted, at the constitutional level, the National System of Science, Technology and Innovation (SNCTI)[27], which describes the complex network of norms and institutions of the various federative entities under the general duty of stimulating science and technology, which results from article 218 of the CF/88[28].

The difference is that a national law is foreseen to regulate the system (BARBOSA, 2015). It is important to highlight, as Marques (2018) points out, that the implementation of a true National System of Science, Technology and Innovation, in which government entities, universities, researchers and companies act in collaboration, is not only a great challenge, but a necessity in the face of what has been called the "Fourth Industrial Revolution"[29], in the terms used by Klaus Schwab.

26 Analyzing the constitutional articles, Peck (2018) states it is important to emphasize that, due to the update carried out by the Constitutional Reform of 2015, technological cooperation contracts were raised to the level of constitutional protection. Therefore, article 219-B essentially creates a National Innovation System that seeks to integrate public and private entities in research activities, which, of course, can benefit the startup ecosystem in Brazil.

27 Paragraph 1 of Art. 219-B, of the Federal Constitution, states that "[...] federal law shall provide for the general rules of the SNCTI." So far, there is no publication of the respective legislation, but, Ordinance no. 2808, of May 29, 2018, of the Ministry of Science, Technology and Innovation and Communications, established "[...] a working group with the attribution of preparing a draft bill to provide for the general rules of the National System of Science, Technology and Innovation (SNCTI), as provided for in paragraph 1 of article 219-B of the Federal Constitution." However, on October 28, 2020, Decree no. 10.534, which establishes the National Innovation Policy and provides for its governance, was published.

28 It is also interesting to analyze to what extent art. 219-A and 219-B of CF are related. While the former deals especially with collaboration between public agencies and companies, in order to transform scientific knowledge into applied innovation, the latter deals with how all the diversity of actors – both public and private – must coordinate their actions and act collaboratively, so that the objective of technological, scientific and innovative development can be achieved.Therefore, it is clear that the norms are complementary in their function. Bearing in mind that art. 219-A, CF, was regulated by Law n. 13,243/2016, now the Legislator's task is to regulate art. 219-B, CF, providing for the components, structure and functioning of the National System of Science, Technology and Innovation, to avoid wasting resources and repeated actions, making the performance of the various actors more efficient and effective (MARQUES, 2018, p. 2131).

29 According to Schwab (2016, p. 16), the Fourth Industrial Revolution began at the turn of the century and is based on the digital revolution. "It is characterized by a more ubiquitous and mobile internet, by smaller and more powerful sensors that have become cheaper, and by artificial intelligence and automatic learning (or machine learning). [...] the Fourth Industrial Revolution creates a world where physical and virtual manufacturing systems cooperate globally and flexibly. This allows for full customization of products and the creation of new operating models. The Fourth Industrial Revolution, however, is not just about smart connected systems and machines. Its scope is much wider. Waves of new discoveries are occurring simultaneously in areas ranging from genetic sequencing to nanotechnology, from renewable energy to quantum computing. What makes the Fourth Industrial Revolution fundamentally different from previous ones is the fusion of these technologies and the interplay between the physical, digital and biological domains."

Given this scenario, it is inferred that the current constitutional text strengthens science, technology and innovation, as well as opens up the expectation of a horizon to discuss the theme in public and private scenarios, striving for the combination of efforts between institutions[30]. However, in the 21st century, the emphasis on innovation, the focus of this work, does not affect only the Federal Constitution. All sectors of society understand the urgency of regulating the issue[31] and the need to create public policies[32] to encourage innovation[33], with a view to advancing national development.

30 From the reading of these articles, it is clear that the constitutional order tends to achieve "technological autonomy", with the State having to promote and encourage science, research and technology. It should be noted that Constitutional Amendment n. 85, of February 6, 2015, reinforced the role of the State in the field of Science and Technology, inserting in the constitutional text the State duty to promote Innovation and determining that the State adopt public policies aimed at promoting and encouraging, in addition to scientific development, research, scientific and technological training, and including Innovation (SANTOS; SILVA, 2018, p. 134).

31 In the same sense, Matias-Pereira and Kruglianskas (2005, p. 1015) state that "[...] creating the conditions for the country to be able to advance consistently in the technological field is an arduous task, which requires, in addition to institutional and economic changes, also a cultural change. It is noticeable, therefore, that the driving force to enable the increase in scientific and technological production in the country begins with the creation of regulatory instruments for this relationship."

32 As Timm and Brendler (2009) indicate, in order to achieve economic development, the most appropriate path, according to the Schumpeterian theory, is that innovation constitutes an essential factor for this desideratum; which is why, currently, the development of knowledge has assumed a prominent place in public policies and investments in the public and private sectors, and nations and organizations around the world seek the factors that induce economic efficiency in science and technology. Public policies on STI in developed countries are focused on strengthening what the neo-Schumpeterian approach calls the National Innovation System (NIS).

33 As Santos and Silva (2018) point out, it can be said that the law is reflexive, the result of a social moment. Because of this scenario, States must seek instruments that can enable the adjustment of the legal system in relation to STI .

Conclusion

Innovation, whether technological or social, is an element that has become part of the agenda of various actors in the economic and social process. As stated by Schwab and Davis (2018), when commenting on the Fourth Industrial Revolution, we are experiencing a new chapter in human development, a huge change, even if it doesn't seem important to those whose lives go through a series of small but significant everyday adjustments.

This change of mindset, which involves society as a whole, has been fostered in Brazil, which has aligned, in recent decades, the base text of the Federal Constitution to serve as a foundation for the development of innovation legislation in the country.

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Santa Catarina's science, technology and innovation policy as a regulatory instrument and innovation booster

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Introduction

Santa Catarina is nationally renowned when it comes to technology and innovation, and the numbers that attest to the growth in these sectors are impressive. This comes as the result of social, economic, cultural and geographic characteristics, as well as an endeavor that began a few years ago and consolidated the state's position as one of the best in the country in terms of educational development, and in the scientific and technological field.

It was recently announced that five companies among the top 10 in the southern region are located in Santa Catarina (ECONOMIA SC, 2021). In 2020, Santa Catarina became the sixth largest group of technology companies in the country and had the sixth highest revenue in the same sector, with 17,720 companies and over R$ 19.8 billion invoiced. In addition, the productivity of technology companies in Brazil proves the efficiency of Santa Catarina, which occupies third place in the national ranking, with the revenue of companies from Santa Catarina totalling BRL 65,800 per employee per year, surpassing the Brazilian average of BRL 56,200 (ACATE, 2021, p. 10).

These numbers reflect a process construction and development in the state, whose starting point can be considered the creation of the Federal University of Santa Catarina (UFSC) in 1960, and, a few years later, in 1986, the implementation of the Celta Incubator, one of the first in the country. In this context, it is also important to highlight the institution of Santa Catarina Policy of Science, Technology and Innovation in 2009, aiming at sustainable regional development based on education, science, technology and innovation (SANTA CATARINA, 2010).

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Thus, given the importance of the technology and innovation sector for Santa Catarina, it is paramount to understand the entire trajectory that culminated in these results. This necessarily involves understanding the evolution of the science, technology and innovation policy for Santa Catarina and the contributions that have added to the development of the state.

Evolution of the science, technology and innovation policy

The socio-economic and technological development of nations is a factor of competitiveness in an era of globalization, and innovation is increasingly considered a factor that drives economic growth. Therefore, to promote development in the economic, social and environmental spheres, we need to have an adequate scenario and a diversification of actions that, if related, expand the possibilities of success in the environment. This scenario then allows for a secure relationship in the cooperation between institutions that are dedicated to science, technology, innovation and the distribution of knowledge in the *locus* where they are found.

Thus, the need for a great deal of investment by the government, industry and educational and research institutions in this sector is required with the aim of transforming scientific knowledge into an assortment of products and processes in terms of competitiveness. In this sense, in the governmental area in Brazil there is a legal framework that regulates the promotion of Science and Technology that serves as a mechanism to regulate, organize and promote the success of the aforementioned development.

It is important to point out that the structures for promoting scientific and technological development in the country were established a while back and may be in need of change. To have an idea regarding this issue, Table 1 below presents the date the first development agencies were established:

Table 1. Creation of the first development agencies in Brazil

Agency	Date established
National Council for Scientific and Technological Development (CNPq)	January 15, 1951
Coordination for the Improvement of Higher Education Personnel (Capes)	July 11, 1951
Foundation for Research of the State of São Paulo (FAPESP)	October 18, 1960
Technical-scientific development fund (BNDES Funtec)	May 29, 1964
Foundation for Research of the State of Rio Grande do Sul (FAPERGS)	December 31, 1964

Funding Authority for Studies and Projects (Finep)	July 24, 1967
Foundation for Research of the State of Rio de Janeiro (FAPERJ)	June 16, 1980
Foundation for Research of the State of Minas Gerais (FAPEMIG)	May 20, 1986
Foundation for Science and Technology of the State of Pernambuco (FACEPE)	December 26, 1989
Foundation for Science and Technology of the State of Santa Catarina (FUNCITEC)	January 9, 1997

Source: by the authors (2022).

It is clear that one of the first initiatives to give support to scientific development began in 1951 with the creation of CNPq and Capes, two highly relevant agencies for the country to this day. Still, another point that must be considered in the growth of scientific production is the establishment of the FAPs (Fundações de Amparo à Pesquisa – Foundations for Research) by different states, beginning with FAPESP in 1960. The FAPs are important for the capillarity of scientific and technological development in all the regions in Brazil, since there are currently more than 20 institutions spread across the country which make significant investments in science.

In relation to the legislation that regulates and encourages scientific development, as a starting point in this study we must mention the Federal Constitution, which has a specific chapter for science, technology and innovation and, in Art. 218, provides that the State will promote and encourage scientific development, research, scientific and technological training and innovation (BRASIL, 1988).

Still at the federal level, another important legislation was Law no. 10.973/2004, known as the Legal Framework for Innovation, which instituted the National Policy for Innovation and provides for incentives for innovation and scientific and technological research in the productive environment. This legislation is a reference, since it considers updating the current environment for research and development in the country.

In January 2016, the Legal Framework for Science and Technology in Brazil was amended with the publication of Law no. 13.243. The new Law promoted significant changes, and its main purpose was to facilitate the approximation of companies and universities, encouraging more research, scientific and technological development and innovation in the country.

These laws demonstrate the need to create mechanisms to strengthen innovation environments across the country, as well as mechanisms that allow states to structure referrals to design and develop public policies for the promotion of science, technology and innovation. In this context of state obligations, in Santa Catarina, the State Constitution affirms that it is the State's duty to promote, encourage

and support scientific development, research and technological training (SANTA CATARINA, 1989).

It is also important to highlight the importance of agricultural research in strengthening innovation in Santa Catarina. In 1991, the Company for Agricultural Research and Rural Extension of Santa Catarina (Epagri) was created by merging several companies linked to the Department of Agriculture. This company played a fundamental role in the development of agriculture in the state, further strengthening the economy of Santa Catarina (EPAGRI, 2015).

Still, with the aim of helping to define policies and strategies for the science and technology sector, the state of Santa Catarina, through Law no. 10.355 of 1997, created FUNCITEC (Fundação de Ciência e Tecnologia – the Foundation for Science and Technology), with financial, technical-scientific and administrative autonomy to develop its activities (SANTA CATARINA, 1997).

At the time, the budget available for scientific research was provided for in the State Constitution, which established that 2% of current revenues would be allocated to scientific and technological research, with half of the amount given to agricultural research, through Fepa and FUNCITEC (EPAGRI, 2015).

In 2005, through Complementary Law no. 284, of February 28, 2005, FUNCITEC was transformed into FAPESC (Fundação de Apoio à Pesquisa Científica e Tecnológica do Estado de Santa Catarina – Foundation for Research and Innovation of the State of Santa Catarina), which was linked to the State Department for Education, Science and Technology (SANTA CATARINA, 2005).

In 2007, Complementary Law no. 381 was passed, linking FAPESC to the State Department for Sustainable Economic Development and emphasizing the competence of the State Council for Science, Technology and Innovation as a collegiate, normative and advisory body linked to the State Governor's Office for the formulation and evaluation of state policy on Science, Technology and Innovation (SANTA CATARINA, 2007).

Since the creation of the Legal Framework for Innovation, in 2004, the states began to institute state innovation laws, and Santa Catarina was one of the first to pass its Santa Catarina Innovation Law. In 2008, Law no. 14.328 was enacted, creating the State System of Science, Technology and Innovation of Santa Catarina. This law is also known as the Diomário Queiroz Law (Queiroz was a former FAPESC president in charge of organizing and structuring the norm).

The Santa Catarina Innovation Law brought along important definitions, establishing measures to encourage scientific and technological research and innovation in the productive environment, aiming at training in science, technology and innovation, regional balance

and the sustainable economic and social development of the state (SANTA CATARINA, 2008).

In addition, the Law presented important conceptual definitions that contribute to the development of the ecosystem, such as: innovation, technology park, business incubator, Center for Technology Innovation, etc. It also brought definitions regarding: a) the endorsement of innovation in scientific and technological institutions in the state of Santa Catarina; b) the centers for technology innovation; c) encouraging the participation of public researchers and independent inventors in innovation activities; as well as the participation of companies in technological innovations of interest to the state; d) state participation in investment funds for innovative companies; e) technology parks and incubators of innovative companies and other innovation environments (SANTA CATARINA, 2008).

This norm also regulated the creation of the Santa Catarina State System of Science, Technology and Innovation. Still, another important achievement was the prediction of allocating 1% of the state's net revenue to FAPESC and the same percentage to Epagri (SANTA CATARINA, 2008).

Subsequently, in 2009, Decree no. 2.372 was enacted, regulating Law no. 14.328/2008 and bringing new conceptual definitions and establishing criteria for the implementation of the Santa Catarina Innovation Law, as well as for the operationalization and accountability of innovation projects (SANTA CATARINA, 2009).

After all this journey of regulation and development, in 2010, the Santa Catarina Policy on Science, Technology and Innovation (PCCT&I) was published, which is delimited as follows:

> It consists of the strategic direction of the government, of teaching, research and outreach institutions and economic and social agents, for the advancement of knowledge, the development of new technologies, the conception, development and incorporation of innovation that contribute to the improvement of the quality of life of all the inhabitants of Santa Catarina, in a sustainable manner. (SANTA CATARINA, 2010).

It is also important to clarify that the Santa Catarina Science, Technology and Innovation Policy was passed unanimously by the members of the State Council for Science, Technology and Innovation (CONCITI). The text of the policy was proposed after a broad open process of consultation with teaching, research and outreach institutions, as well as economic and social agents and government bodies. The process was coordinated by a commission constituted by FAPESC, which prepared a preliminary text submitted for analysis and approval to its Superior Council (SANTA CATARINA, 2010).

One of the objectives of the policy was to overcome regional imbalances and the backwardness of several municipalities and regions. Through

government decentralization, efforts were made to transform each of the state's regions into territories for innovative development, valuing people and local potential (SANTA CATARINA, 2010).

During this period, decentralization took place through the creation of 36 Regional Development Departments, which, in various state regions, availed themselves of the cooperation between the strengths and competences of educational institutions, government and economic and social agents, as a lever for innovative and sustainable development to improve the quality of life of citizens (SANTA CATARINA, 2010).

The PCCT&I established six principles to be followed, namely: 1) social justice; 2) respect for life, human and environmental health, and the cultural values of the people; 3) the rational and non-predatory use of natural resources; 4) preservation and enhancement of the environment; 5) civil society and community participation; and 6) permanent incentive in training human resources (SANTA CATARINA, 2010).

The strategic axes for the implementation of PCCT&I were also defined, which are: I) the Expansion and consolidation of the Santa Catarina STI System; II) Scientific and technological research; III) Innovation and Entrepreneurship; and IV) Sustainable Social and Regional Development through STI (SANTA CATARINA, 2010).

In addition, the Policy presents three fundamental premises that must be observed for its execution and consolidation, namely:

> 1) Education, culture, scientific and technological knowledge and innovation, in the current globalized scenario, are essential to gain and maintain the competitiveness of companies and productive organizations, to modernize the State and for economic and social development, with environmental sustainability;
> 2) Fostering, articulating and supporting actions by the state is a key element for STI;
> 3) Spatial decentralization and institutional deconcentration of scientific and technological knowledge are essential to reducing social inequalities and promoting balanced regional development. (SANTA CATARINA, 2010).

The Policy also foresaw what the lines of action and priorities would be, as well as several programs in each area. All these PCCT&I definitions and strategies were created to achieve its general objective, which is to promote the advancement of scientific and technological knowledge and innovation in the productive environment; in teaching, research and outreach institutions; in economic and social agents and in government bodies, aiming at the quality of life of inhabitants and the social and economic development of the state of Santa Catarina, with environmental sustainability and regional balance (SANTA CATARINA, 2010).

Based on this entire legal framework, which was presented over the years, programs and actions were implemented with the aim of achieving the defined policy and promoting innovative

entrepreneurship, contributing to the already mentioned prominence of the state of Santa Catarina in this context.

Santa Catarina legislation as a support for innovation

Santa Catarina is one of the most innovative states in the country and this is the result of strategies adopted a few years ago for strengthening STI, which counted with the presence of Community Institutions of Higher Education spread throughout the state that offered a distinctive condition for each of the regions and where a group of qualified professionals was made available for regional development. In this context, it is important to stress that, based on the Santa Catarina Innovation Law, several municipalities in the state created their legislation dealing with STI, as can be seen in Table 2.

Table 2. Santa Catarina municipal legislation on science, technology and innovation

Town	Legislation	Description
Luzerna	Law n. 977, of May 4, 2011	Amends Law no. 615 of October 20, 2005, which deals with the municipal policy for economic development, granting material incentives and establishing the municipal council for economic development in the town of Luzerna (SC) and other measures.
Joinville	Law no. 7.170, of December 19, 2011	Deals with incentive measures for innovation and scientific and technological research in the municipal productive and social environment and makes other provisions.
Chapecó	Law no. 6.476, of October 15, 2013	Provides for the municipal policy to encourage technological innovation; creates the council and the municipal fund for science, technology and innovation and takes other measures.
	Decree no. 17.097, of January 27, 2017	Regulates Complementary Law no. 432, of 2012, which provides for systems, mechanisms and incentives for technological and innovative activity, aiming at the sustainable development of the city of Florianópolis and establishes other measures.
Tubarão		Creates the municipal policy for science, technology and innovation and establishes measures to encourage and support its actions and strategies in the business, entrepreneurial, academic and social ecosystem in the town of Tubarão and other measures.
Araranguá		Deals with systems, mechanisms and incentives for technological and innovation activity, aiming at the sustainable development of the town of Araranguá, in compliance with the provisions of article 218 of the CF, article 3 of Federal Law no. 10.973, of December 2, 2004 and article 4, IV, of State Law no. 14.328, of January 15, 2008. (Wording provided by Complementary Law no. 212/2018).

Concórdia	Law no. 5.029, of December 13, 2017	Establishes the municipal policy to encourage technological innovation; creates the municipal council and fund for science, technology and innovation, and takes other measures.
Blumenau		Provides for systems, mechanisms and incentives for technological innovation activities, aimed at the sustainable development of the town of Blumenau.
Rio do Sul		Creates and provides for the municipal science, technology and innovation policy and establishes measures to encourage and support its actions and strategies in the business, entrepreneurial, academic and social ecosystem in the town of Rio do Sul and other measures.
Criciúma	Law no. 7.375, of December 13, 2018	Provides for norms to encourage technological and innovation activities carried out by organizations and citizens established or domiciled in the town of Criciúma/SC.
Joaçaba		Provides for norms referring to the municipal policy of economic development and innovation aimed at increasing and promoting economic incentive measures for the consolidation of industrial, commercial activities, environments that support science, technology, entrepreneurship, service provision and innovation in the town and revokes the Law no. 3.721/2007, which specifies and provides for other measures.
Jaraguá do sul	Law no. 8.202, of December 20, 2019	Provides for the program to encourage innovation in the town of Jaraguá do Sul (PII) and other measures.

Source: by the authors (2022), based on the Santa Catarina Innovation Centers Network (2022).

As can be seen in Table 2, the towns are distributed in different regions of the state, which also contributes to the decentralized development strategy. Also with the aim of strengthening the innovation ecosystem in Santa Catarina, in 2014, the state government created a program for structuring the construction or implementation of Innovation Centers in various regions of the state, called the Santa Catarina Innovation Center Network.

In the first phase, 13 cities (and their micro-regions) were chosen, to receive the buildings that would accommodate the Centers based on technical criteria linked to the maturity of the innovation ecosystem. In a second phase, new Centers, emerging from initiatives by local authorities, joined the Network (SANTA CATARINA, 2017).

Currently, the Network of Centers includes 15 cities that are operating or finalizing construction, namely: Chapecó, Joaçaba, Videira, Caçador, São Bento do Sul, Lages, Criciúma, Tubarão, Florianópolis, Brusque, Rio do Sul, Blumenau, Itajaí, Jaraguá do Sul and Joinville.

These environments are considered *hubs* for the development of innovative businesses and new businesses and provide a base of

regional support for entrepreneurs (TEIXEIRA et al., 2016). Innovation Centers act as boosters of regional ecosystems, accelerating their maturation. Their function is to activate the innovation ecosystem, creating an innovative and entrepreneurial culture, while generating and scaling innovative businesses (SANTA CATARINA, 2017).

The innovation center provides physical space, a number of shared services and mechanisms that accelerate the businesses developed there, in addition to connecting entrepreneurs, educational institutions, government and the community. Hence, it contributes to the strengthening of innovation and the development of the region where it is established.

Another strategy of the Santa Catarina government that contributed to the consolidation of the innovation ecosystem was the creation of a program called "Pact for Innovation", which began in 2017, and whose mission was to unite government, universities and supporting institutions, as well as companies and communication channels, in a movement to advance Santa Catarina as an economy of knowledge and innovation (REDE CATARINENSE DE CENTROS DE INOVAÇÃO, 2022).

Still, another point worth mentioning is the understanding that education is one of the pillars for development. In this sense, the government of Santa Catarina has invested in higher education, as can be seen in art. 170 and 171 of the State Constitution which provides for scholarships for undergraduate and graduate students. In addition, there are scholarships granted by the Fund for the Maintenance and Development of Higher Education (Fundo de Apoio à Manutenção e ao Desenvolvimento da Educação Superior – FUMDES).

These scholarships are made available through the University Scholarship Program of Santa Catarina (Uniedu), in which scholarships are offered for undergraduate (bachelor's, teaching and technologist) and graduate (specialization, master's and doctoral degrees) levels. In recent years, investments in this area have been truly important for the consolidation of knowledge in Santa Catarina, and in 2021 alone, BRL 467 million were to be allocated for higher education students through Uniedu (SANTA CATARINA, 2022).

Throughout these years and in every action taken to strengthen Science, Technology and Innovation, the role taken on by FAPESC should be highlighted, especially in recent years: in 2019 its administrative reformulation took place and investments came to approximately BRL 36.5 million (INOVALE, 2022).

Just two years later, in 2021, this value multiplied: the Foundation's investment was BRL 153,467,400.00, to be used in public notices and implemented over the next few years. FAPESC has developed several programs to encourage innovation, scholarships for master's and doctoral degrees, events, science and research, and has

steadily contributed to the strengthening of science, technology and innovation in Santa Catarina (INOVALE, 2022).

All these initiatives, laws, programs and investments have made Santa Catarina appear on the national scene as one of the most innovative states in the country. The Industry Federation of the State of Ceará (Federação das Indústrias do Estado do Ceará – FIEC) annually publishes a report with the innovation index of the states to demonstrate the main aspects related to innovation, the level each state has attained and essential information for the development of public policies that foster an innovative ecosystem in Brazil.

The FIEC States Innovation Index understands that innovation is made up of a set of complexities, with characteristics, causes and consequences that are specific to each environment (FIEC, 2021). Therefore, a composite index of capabilities and results is built, analyzing several indicators that are relevant to strengthen productivity and competitiveness, identifying the situation in each state. In this context, according to the FIEC innovation index, the state of Santa Catarina finds itself in an outstanding position nationally, ranking second overall. This ranking can be better visualized in Table 3, which presents the general index.

Table 3. FIEC State Innovation Index

State	Index 2021	Ranking 2021	Ranking 2020	Comparison 2021-2020
São Paulo	0.796	1	1	–
Santa Catarina	0.508	2	3	
Rio Grande do Sul	0.448	3	2	
Rio de Janeiro	0.441	4	4	–
Paraná	0.420	5	5	–

Source: FIEC (2021, p. 20).

It is abundantly clear that Santa Catarina has demonstrated that investments in Science, Technology and Innovation are important for competitiveness and strengthening the state's innovative ecosystem.

Conclusion

By presenting the panorama of legislative and governmental initiatives that contributed to the development of the Santa Catarina innovation ecosystem, we can understand the effort and success in the implementation of this development policy. Santa Catarina stands out nationwide as an innovative state – however, there are still strategies that can be implemented, while those that are already in place can be improved, so that the innovation ecosystem may

become even stronger and Santa Catarina consolidates itself as an innovative state. A strong educational base, with a structure of Innovation Centers spread across the main cities of the region, always in alliance with a community university in its vicinity, has enabled the state to envision, a new and broad process of future development based on organized public policies, which have been achieved so far by the strategies developed in the past.

In this sense, it is has been demonstrated that Santa Catarina has a Policy for Science, Technology and Innovation and several laws that regulate the consolidation of these areas, which are important instruments for the sustainable economic development of the state. The implementation of this legislation, along with the strength of the state of Santa Catarina, which already has its entrepreneurial power as a characteristic, creates a distinctive condition for the effectiveness of regional development.

Based on this, we can understand that, as a result of the established legal framework and of PCCT&I initiatives, which can advance with consolidated examples of innovative regions spread around the world, there is no doubt that Santa Catarina has shown that it is an innovative state with a structured innovation ecosystem that stimulates the development of its regions, and is a favorable model for development and stressing the leading role of the state of Santa Catarina.

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Part 02.

NATIONAL AND SANTA CATARINA LEGAL FRAMEWORKS FOR SCIENCE, TECHNOLOGY AND INNOVATION: ADAPTATIONS AND IMPROVEMENT PROPOSALS

Impacts of the new national legal framework on science, technology and innovation policy in Santa Catarina

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Introduction

One challenge, among many, faced by project executors within the economic sphere is investing in science, technology and innovation in an environment in which dimensions do not work, interact or promote the expected results. For Segundo (2019, p. 57), these dimensions are: i) personnel, with a high level of training; ii) state-of-the-art facilities; iii) financial resources; iv) adequate, feasible, efficient and effective legislation and standards.

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For Araújo et al. (2018, p. 1-4), the enactment of a legal framework for innovation has led Brazil to the promotion of mechanisms that allow it to recover from a lack of technological advancement and to place innovation as an essential factor for development.

Araújo et al. (2018, p. 4) state that: "Innovation is much more than a concept or a practice, it is a need, an attitude of action and methodology for training human resources in the face of the need a country has for development and sustainability."

With these perspectives, many Brazilian states have adopted their own innovation legislation, as is the case of Minas Gerais (Law no. 17.348/2008) and Rio de Janeiro (Law no. 13.196/2009). Municipalities such as, Presidente Prudente/SP (Law no. 9.086/2016) and Maringá/PR (Law no. 10.407/2017), move in the same direction.

Santa Catarina, in turn, has devices that deal with science and technology inserted in its constitution. There is also specific legislation on the subject. This is Law no. 14.328/2008, amended by Law no. 16.382/14, which provides for measures to encourage scientific and technological research and innovation, and its Regulatory Decree no. 2372/2009.

It so happens that the approval of Constitutional Amendment no. 85/2015 brought changes that impact state sectoral legislation. As a result, the Constitutional Amendment Project 0001.0/2021 is pending in the Legislative Assembly of the State of Santa Catarina, whose

objective is to adapt the text of the Santa Catarina poliCTIal charter to the dictates of the Amendment to Federal Constitution no. 85/2015.

In this context, this research aims to point out the possible impacts of Constitutional Amendment no. 85/2015 on Santa Catarina science, technology and innovation legislation.

We begin with the identification of aspects of the science, technology and innovation (STI) policy in Santa Catarina, such as its creation, legal foundations, objectives and articulation. Then, we deal with the effects from the constitutional and legal perspective after the approval of Constitutional Amendment no. 85/2015.

This research is analytical, based on the deductive method, and makes use of bibliographical and documentary research.

Important milestones in Santa Catarina's STI policy

States are important protagonists in the field of science, technology and innovation, especially with regard to the elaboration of public policies and the construction of a legal architecture capable of ensuring legal certainty to the agents of the science, technology and innovation ecosystem. It is this structure that favors the creation of an environment suitable for creativity, the driving force behind innovation. According to Rosa (2018, p. 3):

> Public Policies can be understood as a range of decisions, plans, goals and government actions – at the national, federal, state, district and/or municipal levels – aimed at solving problems of public interest – which can be a specific problem [...]. Technological innovations are umbilically linked to public policies, as they depend on investments in teaching, culture, research, development and science.

The trajectory of Santa Catarina policies started in 1960, when Brazilian government planning, aiming towards economic development, gained a wider scope. During this period, the Government of Santa Catarina promoted changes in the granting of incentives, credits and infrastructure (MOSER; VARGAS; THEIS, 2012, p. 9-11).

According to the acting governor in 2009, Luiz Henrique da Silveira, the starting point of Santa Catarina's STI policy can be considered:

> [...] the creation of the Federal University of Santa Catarina, in 1960. It is the synthesis of the past of competent work of many people and institutions, and, at the same time, the strategic challenge that unites government, academia and economic and social agents, aiming at the quality of life of the inhabitants and the development of Santa Catarina, with environmental sustainability and regional balance. (SANTA CATARINA, 2010, p. 6).

However, according to Moser, Vargas and Theis (2012, p. 9-11), "[...] until then, little, if any, reference had been made to a Science and Technology Policy for Santa Catarina."

In January 2003, Mr. Luiz Henrique da Silveira assumed the position of Governor of the State of Santa Catarina. His strategic vision sought to rescue the decentralized development model; his inauguration was also marked by the Administrative Reform in the form of Law no. 243 of January 30, 2003 (MOSER; VARGAS; THEIS, 2012, p. 9-11). For the governor:

> To overcome regional imbalances, and contexts of municipal and regional underdevelopment and social injustice, we implemented a new government policy: decentralization. We transformed each of the regions into territories of innovative development, valuing people and local potential, an indispensable precondition for the generation and dissemination of high-income jobs and social well-being. (SANTA CATARINA, 2010, p. 5).

In 2005, the *Master Plan* was elaborated by the Secretary of Planning, Budget and State Management. Briefly, the strategic plan was premised on assessing the competitiveness of regional production chains, indicating bottlenecks and defining the priority segments to receive incentives from the Government. The report pointed out that strategic actions should be prioritized in transport logistics, energy, science & technology and finance (MOSER; VARGAS; THEIS, 2012, p. 11).

Soon after, the Strategic Development Program based on Innovation was created, whose purpose was to analyze local productive arrangements and regional productive chains in the state of Santa Catarina (MOSER; VARGAS; THEIS, 2012, p. 12).

In 2006, in compliance with article 10 of Complementary Law no. 284 (SANTA CATARINA, 2005), the Santa Catarina Development Plan (Plano Catarinense de Desenvolvimento – PCD/2015) was created, establishing guidelines for government action between 2007 and 2015, including support for science and technology innovation as a way to promote sustainable development (MOSER; VARGAS; THEIS, 2012, p. 12).

Aiming to establish measures to encourage scientific and technological research and innovation, as well as regional balance and the sustainable economic and social development of the state, on January 15, 2008, the Innovation Law of the State of Santa Catarina was created (SANTA CATARINA, 2008).

In article 2, the law indicates important concepts, such as: i) innovation: "Introduction of a novelty or improvement in the productive or social environment that results in new processes, goods or services"; ii) creation: "Invention that leads or may lead to the emergence of a new product, process or incremental improvement, obtained by one or more creators"; iii) Science, Technology and Innovation System: set of organizations that "[...] interact with each other and spend resources to carry out activities aimed at the generation, dissemination and application of scientific and technological knowledge that provide innovative processes, goods and services." (SANTA CATARINA, 2008, p. 2).

Article 3 of the law instituted the State System of Science, Technology and Innovation of Santa Catarina, with the purpose of enabling the

articulation of public and private organizations, the structuring of actions for the strengthening of institutions, interactions with productive arrangements and the construction of support channels for technological innovation (Santa Catarina, 2008, p. 2).

The law lists, in its article 4, the bodies that make up the State System of Science, Technology and Innovation of Santa Catarina: State Council of Science, Technology and Innovation (CONCITI), the State Office for Sustainable Economic Development, the Santa Catarina Foundation for Research and Innovation (FAPESC), Municipal Secretaries, the University of the State of Santa Catarina (UDESC), the Corporation for Research in Agriculture and Rural Outreach of Santa Catarina (Epagri), universities and other higher education institutions that work in science, technology and innovation and other qualified entities such as ICTESC, Technology Parks and Incubators of Innovative Companies and Companies with relevant activities in the field of innovation (Santa Catarina, 2008, p. 3).

The law authorizes ICTESCs to enter into agreements to develop technology innovation projects with public and private institutions (Santa Catarina, 2008, p. 3) and allows the state to establish medium and long-term institutional support for private, non-profit institutions whose attention is focused on research and technological development (Santa Catarina, 2008, p. 6).

Furthermore, it provides for the allocation of at least 2% of the state's current revenue, excluding the portion belonging to the Municipalities, to scientific and technological research, with at least half to agricultural research (Santa Catarina, 2008, p. 10 – Writing given by Law no. 16.382 of 2014). Finally, it allows the promotion of innovation in companies through tax incentives.

In order to regulate State Law no. 14.328/2008, on June 9, 2009, State Decree no. 2.372, which establishes, in one of its first determinations, that the State Secretary for Sustainable Economic Development (SDS), and the Santa Catarina Foundation for Research and Innovation (FAPESC) promote, at least, an annual conference on science technology and innovation, in order to publish assessments and strategic guidelines (Santa Catarina, 2009, p. 1).

The decree indicates the guidelines for the celebration of direct or indirect agreements, of a financial nature, by bodies or entities of the state public administration whose objective is the execution of government programs and actions (Santa Catarina, 2009, p. 4).

For the non-profit private sector, the norm establishes the concession of

> [...] financial, human, material or infrastructure resources to be adjusted in terms of partnership, agreements or specific contracts, destined to support research and development activities focused on the priorities of Santa Catarina's innovation policy. (SANTA CATARINA, 2009, p. 2).

From that period until the official proposal of the Santa Catarina Policy of Science, Technology and Innovation, public consultation took place with teaching, research and extension institutions, economic and social agents, and government bodies. This process was coordinated by a commission constituted by FAPESC (SANTA CATARINA, 2010, p. 5).

The approval of the Santa Catarina STI Policy took place on September 11, 2009, unanimously among the members of the State Council for Science, Technology and Innovation (CONCITI). According to the former governor of Santa Catarina, Luiz Henrique da Silveira (SANTA CATARINA, 2010, p. 5), it was created to overcome "[...] regional imbalances, and contexts of municipal and regional underdevelopment and social injustice [...]".

The policy basically consists of:

> [...] the strategic direction of the government, of teaching, research and extension institutions and of economic and social agents for the advancement of knowledge, the development of new technologies, the design, development and incorporation of innovations that contribute to qualityof life improvement of all the inhabitants of Santa Catarina in a sustainable way. (SANTA CATARINA, 2010, p. 7).

In its application, the following principles must be observed: social justice, respect for life, human and environmental health, cultural values of the people, rational use of natural resources, preservation of the environment, participation of society and permanent incentive to train human resources (SANTA CATARINA, 2010, p. 39).

Its fundamental pillars, which promote the maintenance of company competitiveness, economic and social development, the reduction of social inequalities and environmental sustainability, are: i) education, culture, scientific and technological knowledge and innovations; ii) state actions and support; iii) spatial decentralization and institutional deconcentration of scientific and technological knowledge (SANTA CATARINA, 2010, p. 39).

The main objectives of the policy are:

> a) to promote access to scientific and technological knowledge as a basis for economic and social development; b) to promote the advancement of knowledge on topics of interest to the development of Santa Catarina; c) to favor the generation of new ideas, products and processes and the corresponding intellectual protection, aiming at the incorporation of innovations by productive organizations and public and private institutions; d) to support technological development and innovation in companies in traditional sectors and in micro, small and medium-sized companies; e) to ensure national and international competitiveness and the quality of Santa Catarina products, through the production and sale of goods and services with high added value; f) to support research and technological innovations aimed at the sustainable use of natural resources and the enhancement of the environment; g) to evaluate the results of research and innovations carried out with public resources in terms of cultural, scientific, technological, environmental, economic and social impact. (SANTA CATARINA, 2010, p. 39-40).

Its strategies are divided into four main axes: i) expansion and consolidation of the STI system in Santa Catarina; ii) scientific and technological research; iii) innovation and entrepreneurship; iv) sustainable social and regional development through STI.

At first sight, we can identify the concern of the state government in promoting actions towards economic, social and environmental development, through the promotion of science, technology and innovation. However, according to Moser, Vargas and Theis (2012, p. 16), the model of a linear chain of innovation put into practice can be questioned "[...] due to the reality of scientific and technological development experienced until then in the country that has not yet shown itself capable of promoting economic and social development and overcoming regional inequalities."

In 2011, at the beginning of the government of Raimundo Colombo, the project called Plano SC@2022 was launched, aiming to stimulate innovation that would promote economic development (SCHOULTEN, 2015, p. 79).

According to Schoulten (2015, p. 79), the SC@2022 Plan was later renamed "SDS for the Programa Nova Economia (New Economy Program)", and had the vision "[...] of making Santa Catarina a national and international reference in the use of innovation for sustainable development." To this end, it aimed to implement a model of economic and social development that would ensure quality of life for all Santa Catarina residents.

The project encompassed four programs: i) NOVAECONOMIA@SC: aiming at increasing the competitiveness of the economy through projects such as Juro Zero (Zero Interest) and Polos Industriais (Industrial Hubs); ii) INOVAÇÃO@SC: structuring and managing the innovation and technology policy; iii) EDUCAÇÃO@SC: preparing human capital through educational programs; iv) MEIOAMBIENTELEGAL@SC: with the purpose of reconciling the preservation of the environment with economic growth (SCHOULTEN, 2015, p. 80).

For Schoulten (2015, p. 105), although the information about the programs lacked in good management of data and results, and the programs' scope and extension were timid, the actions reflected the government's intention of making Santa Catarina walk "side by side with the transformations of the current technological paradigm".

Another project that is also worth mentioning is the Santa Catarina 2030 Development Plan.

> The 2030 vision for the state of Santa Catarina focuses on a society that is a reference in sustainability, innovation, entrepreneurship, and social and regional equity. The proposal consists of carrying out the desired transformation, through innovative undertakings, but in a sustainable way and respecting the fundamental values of society, combining continuity and change. (SANTA CATARINA, 2018, p. 31).

The Plan's pillars are: i) economic development, involving industry, services, science, technology, agriculture, fishing and sports; ii) social development, involving education, health, security, citizenship, civil defense, social assistance; iii) infrastructure and the environment, including infrastructure, urban mobility, environment; iv) public management.

Santa Catarina's STI policy and legislation historically demonstrate the intention to structure and encourage scientific and technological development. There is a concern for the inclusion of external influences, such as industry, civil society and education.

Santa Catarina's STI policy after Constitutional Amendment no. 85/2015 and Law no. 13.243/2016

The initial purpose of what was later consolidated as the STI Legal Framework in Brazil was the creation of a National Code of Science, Technology and Innovation, with the regulation of articles 218 and 219 of the Federal Constitution and the repeal of the Innovation Law (BARBOSA et al., 2021, p. 27).

The House Bill (Projeto de Lei da Câmara – PLC) no. 2177/2011 aimed to systematize and simplify the sparse legislation on science, technology and innovation.

Among other actions, it also aimed to regulate public-private partnerships, public purchases, the legal regime for civil servants, tax incentives, etc.

However, the Special Committee of the House of Representatives responsible for the debates adjusted the protection of STI activities at a constitutional level through an amendment to the Federal Constitution of 1988 (BARBOSA et al., 2021, p. 27).

Constitutional Amendment no. 85 of February 26, 2015 amends and adds provisions to the Federal Constitution to update the treatment of science, technology and innovation activities.

Its modifications and inclusions reinforced the State's support for policies that, according to Barbosa et al. (2021, p. 35), provided guidance to "[...] technological research with a view primarily to solving the major Brazilian problems and promoting the development of the national and regional productive system." Also, according to the authors, the Constitutional Amendment gave scope to the theme, because it:

> a) altered the material and concurrent legislating powers of political entities on science, technology, research, development and innovation; b) streamlined the possibility of transposition, relocating or transferring resources from a programming category, within the scope of science, technology and innovation activities; c) determined that the Government will grant financial support

> to research, extension and stimulus and innovation promotion activities carried out not only by universities, but also by professional and technological education institutions; d) reinforced the role of the Government in encouraging scientific development, research, scientific and technological training and innovation, including innovative companies and technological centers; e) establishes instruments of cooperation with public bodies and entities and with private entities, including the sharing of specialized human resources and installed infrastructure capacity, for the execution of research, scientific and technological development and innovation projects; and f) determined the creation, by federal law, of the National System of Science, Technology and Innovation that will establish the guidelines for public policy on STI. (BARBOSA et al., 2021, p. 30).

On January 11, 2016, the implementation of the innovation system in Brazil continued through Law no. 13.243, with the purpose of adapting the existing legal framework to the amendments of Constitutional Amendment no. 85/2015.

As discussed in the previous topic, Santa Catarina had specific legislation on the subject. However, the new Legal Framework for Science, Technology and Innovation brought to the constitutional sphere of Santa Catarina the need to update its text regarding the treatment of STI actions and activities.

Thus, on May 25, 2021, Governor Carlos Moisés da Silva presented the Proposed Amendment to the State Constitution (PEC) no. 0001.0/2021, aiming to

> [...] stimulate the economy of Santa Catarina, through the innovation segment, which consists of advances at a global level, based on public policies for socioeconomic development, together with research activities and scientific and technological training. (SANTA CATARINA, 2021).

The proposed changes are summarized in Chart 1.

Chart 1. Changes brought by the Proposed Amendment to the Constitution of Santa Catarina no. 0001.0/2021

Before the Proposed Amendment to the Constitution no. 0001.0/2021	Approved Changes
Art. 9. The state exercises, with the Union and the Municipalities, the following competences: [...] V – provide means of access to culture, education and science;	Art. 9. The state exercises, with the Union and the Municipalities, the following competences: [...] V – provide means of access to culture, education and science, technology and innovation;

Art. 123. It is forbidden: [...] Paragraph 3 Voluntary transfers to the Municipalities will be considered special transfers, with the signing of an agreement or similar instrument being waived, as provided by law.	Art. 123. It is forbidden: [...] Paragraph 3 The transposition, reallocation or transfer of resources from one programming category to another may be admitted, within the scope of science, technology and innovation activities, with the objective of making viable the results of projects restricted to these functions, by means of an act of the Executive Branch, without the need for prior legislative authorization provided for in subparagraph VII of *the head paragraph* (*caput*) of this article.		
Art. 136. In order to increase economic development, the state will take, among others, the following measures: [...] II - Stimulation of scientific and technological research;	Art. 136. In order to increase economic development, the state will take, among others, the following measures: [...] II - Stimulation of scientific, technological and innovation research;		
TITLE IX SOCIAL ORDER [...] CHAPTER IV OF SCIENCE AND TECHNOLOGY	TITLE IX SOCIAL ORDER [...] CHAPTER IV OF SCIENCE, TECHNOLOGY AND INNOVATION		
		Art. 176. It is the duty of the state to promote, encourage and support scientific development, research and technological training.	Art. 176. The state shall promote and encourage scientific development, research, scientific and technological training and innovation. Paragraph 1 Basic scientific and technological research will receive priority treatment from the state, with a view to the public good and the progress of science, technology and innovation. Paragraph 2 Technological research will focus mainly on solving the problems of Santa Catarina and on developing the state's productive system. Paragraph 3 The state will support the training of human resources in the areas of science, research, technology and innovation, including through support for technological extension activities, and will grant those who are responsible for them special means and conditions of work. Paragraph 4 The law will support and encourage companies that invest in research, creation of technology suitable for the state as well as training and improvement of their human resources.The law will also support those companies that practice remuneration systems that ensure the employee, unrelated to salary, participation in the economic gains resulting from the productivity of their job. Paragraph 5 The state, in carrying out the activities established in *the head paragraph* (*caput*) of this article, will stimulate the articulation between public and private entities in the different spheres of government.

	Paragraph 6 The state shall promote and encourage the activities abroad of public institutions of science, technology and innovation, aiming at carrying out the activities provided for in *the head paragraph* (*caput*) of this article. Paragraph 7 The state shall encourage: I – the formation and strengthening of innovation in companies, as well as in other public or private entities; II – the establishment and maintenance of technological parks and centers, and other environments that promote innovation; III – the role of independent inventors; and IV – the creation, absorption, diffusion and transfer of technology; Paragraph 8 The state may sign cooperation instruments with public bodies and entities and with private entities, including the sharing of specialized human resources and installed capacities, for the execution of research projects, scientific, technological and innovation development, through financial or non-financial consideration assumed by the beneficiary entity, as provided by law.
Art. 177. The scientific and technological policy will have the following principles:	Art. 177. The scientific, technological and innovation policy will have the following principles:
There was no Article 177-A in Chapter IV of Title IX of the State Constitution.	Art. 177-A. The State System of Science, Technology and Innovation (SECTI) will be organized in collaboration between public and private entities, aiming at promoting scientific and technological development and innovation. Sole paragraph: The law will provide for the general rules of SECTI.

Source: elaboration by the authors (2022).

Innovation was included in the state constitutional text, becoming a priority and strategic theme for economic and social development actions in Santa Catarina. The proposal was unanimously approved by the Constitution and Justice Commission on June 22, 2021; however, it will only come into force after the date of its publication.

By contrast Law no. 14.328/2008, amended by Law no. 16.382/2014, which establishes measures to encourage scientific and technological research and innovation, and its Regulatory Decree no. 2.372/2009, do not yet have a formal proposal for amendment.

It should be noted that the approval of Proposed Amendment to the Constitution (PEC) no. 0001.0/2021 elevates innovation to constitutional status, making it a priority and strategic theme for economic and social actions development in Santa Catarina. Consequently, investments in research, technology and innovation must be intensified with the articulation of new collaborative structures between public and

private entities, which are fundamental pieces to maximize economic, social and environmental development.

Conclusion

Brazil is making efforts to structure an innovation system, with the articulation of programs, the enactment of laws and the creation of new institutions. The legal framework for innovation is one of the protagonists involved and has brought important mechanisms to boost scientific and technological development. An example is the change to material competence to concurrently legislate political entities on science, technology, research, development and innovation, reinforcing the regional role of the states.

In addition to its constitution, Santa Catarina has specific legislation on the subject, with Law no. 14.328/2008, amended by Law no. 16.382/14, which provides measures to encourage scientific and technological research and innovation, and its Regulatory Decree no. 2.372/2009.

However, Constitutional Amendment no. 85/2015 made it necessary to change the legislation of Santa Catarina, which is currently reflected in the Project for Constitutional Amendment no. 001.0/2021. The project inserts innovation as a priority theme for stimulating the state economic development.

It also reaffirms the state's commitment to the Union and the Municipalities, in order to provide the means of access to science, technology and innovation, in addition to culture and education. It reiterates cooperation between public bodies and entities, with private entities and society.

We concluded that, although the changes have been implemented timidly, they represent the direction the policy has taken to face the regional economic challenges and obstacles, inserting science, technology and innovation as essential factors.

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Legal certainty and incentive to innovation environments: an analysis from the legal framework of science, technology and innovation

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Introduction

In recent years, Brazilian research institutions have significantly expanded the culture of research and innovation, increasing national scientific production. However, the knowledge generated is not always absorbed by society. One of the factors that prevented the best use of knowledge was the set of existing laws, which did not provide agility nor legal certainty to the procedures.

The legal framework for science, technology and innovation amended nine laws, with the aim of creating a more favorable environment for research, development and innovation (RD&I) in universities, public institutes and companies. Federal Decree no. 9.283 of February 7, 2018, among other legislation, regulated Law no. 10.973 of December 2, 2004, and Law no. 13.243 of January 11, 2016, establishing measures to encourage scientific and technological research and innovation in the productive environment, with the aim of promoting technological autonomy and the development of the country's national and regional productive system, under the terms of the Federal Constitution.

The decree is an important milestone for the development of science, technology and innovation in the country, as it creates mechanisms to bring Scientific and Technological Institutions (STIs) and the productive sector closer together, thus increasing the possibilities that research carried out in academia reach companies, which drives Brazil's economic, technological and social development.

In this sense, it is important to know and disseminate the main regulations introduced by the decree, since it creates several mechanisms that aim to encourage the promotion of science, technology and innovation.

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The purpose of this chapter is to verify how the new legal framework can provide legal certainty and encourage the knowledge generated in Science, Technology and Innovation institutions to be better used by society and the production sector, considering the new approach presented by the legislation.

Thus, three important regulations presented by Decree no. 9.283/2018, which consist of: incentives for the development of cooperative projects involving companies, STIs and non-profit private entities; the Centers for Technology Innovation (CTIs) may be constituted with their own legal personality; facilities for the transfer of public STI technology to the private sector, which are important stimulus instruments for the establishment of safe and favorable environments for innovation.

With the adoption of exploratory and descriptive research, we sought to explain and describe the regulations introduced by Decree no. 9.283/2018. The methodology used in this chapter adopts a qualitative approach. As for the sources, this is a secondary bibliographical research based on already published material, consisting of books, periodicals, and other references, in addition to documentary research, which allowed understanding the importance of the New Legal Framework for Science, Technology and Innovation (Novo Marco Legal da Ciência, Tecnologia e Inovação) for the creation of legally safe and favorable environments for innovation.

Stimulus for the development of cooperative projects

Chapter II of Decree no. 9.283/2018 deals with strategic alliances and cooperation projects and establishes that direct, autarchic and foundational public administration, including regulatory agencies, and funding agencies may encourage and support the formation of strategic alliances and the development of cooperation projects[1].

As can be seen, the legislation considered important areas for the scientific and technological development of the country, since the stimulus and support for cooperation projects involving companies, STIs and non-profit private entities, contribute significantly to the increase in partnerships and competitiveness of all involved.

Collaborative actions favor the development of innovation-promoting environments, as well as the exchange of researchers and research networks. Research, development and innovation activities require

1 Article 3 The direct, autarchic and foundational public administration, including regulatory agencies, and development agencies may encourage and support the formation of strategic alliances and the development of cooperation projects involving companies, STI and non-profit private entities aimed at research and development activities aimed at generating innovative products, processes and services and transferring and disseminating technology. Paragraph 1 The support provided for in the head paragraph (*caput*) may include: I - international technological research networks and projects; II - technological entrepreneurship actions and the creation of environments that promote innovation, including parks and technology centers and business incubators; and III – education and training of qualified human resources.

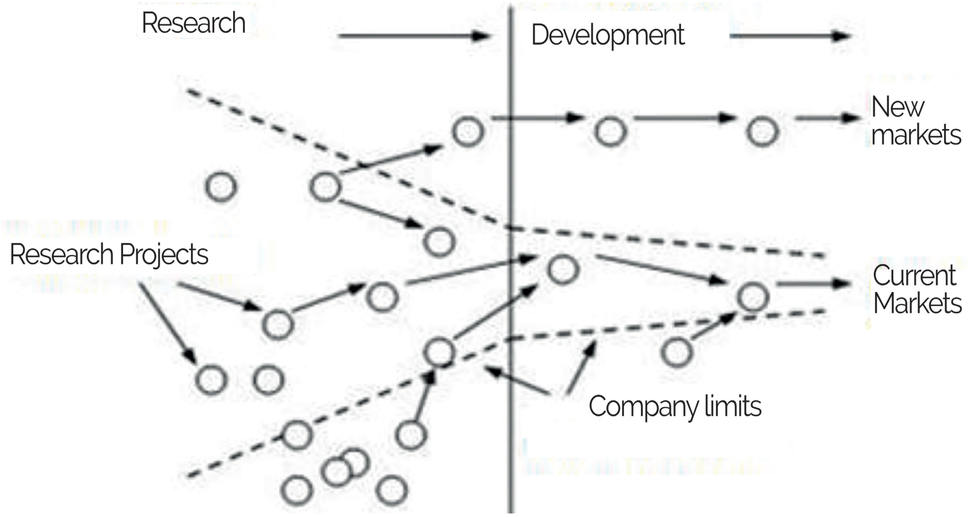
high investments, therefore, through collaborative projects, companies can have STI laboratories, infrastructure and researchers, reducing risks and maximizing results, which makes the activity viable. “Open innovation between organizations promotes the emergence and growth of innovation ecosystems.” (CHESBROUGH; VANHAVERBEKE; WEST, 2018, p. 318).

The open innovation policy comprises an advance in relation to traditional innovation policies “[...] with new approaches that cut across different policy areas to advance and support innovation.” (CHESBROUGH; VANHAVERBEKE; WEST, 2018, p. 322).

In open innovation, research and development are characterized by the opening of borders and the incorporation of external researchers, such as research institutions and universities. Ideas can originate both inside and outside the company.

As shown in Figure 1, in open innovation it is observed that outside the organizational environment there are ideas and projects that can be incorporated. The lines that represent the company’s boundaries are dashed to signify the openness and flow of ideas, presenting research opportunities, but also partnerships between companies, expanding markets, new opportunities for growth, partnerships, and the exchange of experiences.

Image 1. The open innovation paradigm in industrial Research and Development (R&D) management



Fonte: Chesbrough (2012, 9).

Different initiatives fit the concept of open innovation: track ideas in the external environment; seek researchers to solve problems; form a *joint venture*; license technology from a university; participate in networks to coordinate innovation activity (HAGEL; BROWN, 2008).

There is no doubt that universities, as well as other organizations, face many challenges to growth; and also that open innovation proves to be a promising possibility for implementing partnerships that can

promote success in this endeavor (CHESBROUGH; VANHAVERBEKE; WEST, 2018).

Successful initiatives in open innovation depend on an effective connection, with good communication, relationships and respect for the culture of each of the organizations involved in the partnership. In the STIs, Centers for Technology Innovation[2] (CTIs) are responsible for the promotion and monitoring of relationships with other institutions, ensuring institutional policies, which strengthen relationships in collaboration projects.

Legal personality of the Centers for Technology Innovation

CTIs were regulated in Brazil with the advent of the Innovation Law, in 2004, with the purpose of assisting in the management of innovation policies for STIs. These could be created alone or in partnership with more than one institution; however, they would not have their own legal personality.

However, article 16 of Decree no. 9.283/2018 established that CTIs may be constituted with their own legal personality, as a non-profit private entity, including in the form of a support foundation.

The CTIs perform strategic functions in the institutions to which they belong. Law no. 10.973/2004 established several competences[3] that require a qualified staff.

To this end, strengthening the role of intermediary agents and stimulators of public-private relations, represented by CTIs and support foundations, depends on guarantees of greater legal certainty for the development of their activities, as well as changes in their configuration (RAUEN, 2016). The inclusion of its own legal personality, in addition to providing greater legal certainty, allows

2 As stipulated in Law no. 19.973/2004 (Wording by Law no. 13.243/2016), the Center for Technology InnovationCenter for Technology Innovation (CTI) is considered: a structure instituted by one or more STIs, with or without its own legal personality, whose purpose is the management of an innovation institutional policy and, by minimum jurisdiction, the attributions stipulated in this Law.

3 Article 16. To support the management of its innovation policy, the public STI must have its own Center for Technology Innovation or one in association with other STIs. Paragraph 1 Among the competencies of the Center for Technology Innovation referred to in *the head paragraph* (*caput*), are: I - to ensure the maintenance of the institutional policy to encourage the protection of creations, licensing, innovation and other forms of technology transfer; II - to evaluate and classify the results from research activities and projects in order to comply with the provisions of this Law; III - to evaluate the request of an independent inventor for the adoption of an invention in accordance with article 22; IV - to consider the convenience and promote the protection of creations developed in the institution; V - to consider the convenience of disclosing the creations developed at the institution, which are subject to intellectual protection; VI - to monitor the processing of requests and the maintenance of the institution's intellectual property titles. VII - to develop studies of technological prospection and competitive intelligence in the field of intellectual property, in order to guide STI innovation actions; VIII - to develop studies and strategies for the transfer of innovation generated by STI; IX - to promote and monitor the STI's relationship with companies, especially for the activities provided for in articles 6 to 9; X - negotiate and manage STI technology transfer agreements.

operational activities to be carried out with greater flexibility and autonomy.

MacWright (2010), when analyzing the structure of the University of Virginia Patent Foundation, in the United States, presents several advantages in the constitution of a technology transfer office, in the form of a separate corporate entity. For the author, there are great operational and managerial advantages over an internal technology transfer office, which correspond to:

> [...] segregation of legal risk, relief from state-imposed bureaucratic requirements, fast and independent decision-making, flexibility to hire and manage staff, collaborative decision-making by board members who have academic and business backgrounds, profit and risk responsibilities in independent accounting. (MacWright, 2010, p. 63).

Technology transfer is surrounded by several legal risks, which are inevitable and inherent to the activity and constitute a considerable concern for some universities. For this reason, an entity separate from the university protects it, as it segregates the legal risk, which is assumed by the foundation constituted for this purpose. In addition, when a university is public, it is subject to state regulation, suffering various restrictions, which does not apply in the case of separate corporate entities with no connection to the state (MacWRIGHT, 2010).

Another important aspect is the possibility of taking precise and independent decisions, in a time frame that is compatible with the demand. Unlike universities, a separate and independent structure requires fewer internal approvals than an academic administration would. Still, hiring and managing professionals is one of the biggest challenges for many internal technology transfer offices, since, at the university level, there are salary limitations, which makes it impossible to retain valuable team members. A separate structure would avoid such impediments, as the corporation itself would determine staff salaries, allowing the recruitment and retention of highly qualified technology transfer professionals (MacWRIGHT, 2010).

In addition, the creation of a separate structure makes it possible to aggregate academic and commercial knowledge in decision-making, enabling a healthy discussion on administrative decisions. It also allows defining financial profit and loss responsibilities and, above all, enables independent accounting (MacWRIGHT, 2010).

The new legal provision that allows CTIs to acquire their own legal personality demonstrates the state's concern in promoting innovation and technology transfer, allowing such departments, which until then were internal, to receive a new legal status, assuming obligations that until then were the STIs.

The constitution of a CTI, as a support foundation, grants it great management autonomy, ensuring greater efficiency and agility in

the performance of its functions, due to the adopted specialization of its legitimacy for having been created to represent the university in a very delimited area (SANTOS, 2009).

In addition to stipulating the possibility of establishing their own legal personality for the CTIs, the new legal framework was also dedicated to facilitating technology transfer, as will be analyzed in the next section.

Readiness for technology transfer

In Brazil, in recent years, the discussion on technology transfer resulting from cooperation projects between the productive sector and research institutions has been widely disseminated. It highlights the importance of creating mechanisms that facilitate transfers while providing legal certainty to transactions.

Although Brazilian institutions have highly specialized researchers and are responsible for the development of important research, the transfer of results to the production sector is still incipient. In this sense, according to Cruz et al. (2022, p. 1025), "[...] integrating innovation and research carried out by teaching and research institutions to the productive dynamics of the private sector, and adopting efficient mechanisms, is essential in this technology transfer process."

When dealing with innovation, technology transfer is one of the main bottlenecks. Through this legal transaction, the rights to certain technology, knowledge or other intangible assets are transferred so that third parties can develop and exploit this knowledge in their innovative products or services (AREAS; FREY, 2019).

The third chapter of the innovation law, which deals with encouraging the participation of STIs in the innovation process, underwent several changes due to Law no. 13.243 of 2016. Such changes brought greater legal certainty in the practices of cooperation projects and technology transfer.

Initially, in Article 6, the option of the public STI to enter into a technology transfer and licensing agreement granting usage or exploiting rights of a creation developed alone or through partnership was included. That article included the partnership, demonstrating a stimulus to cooperation practices between institutions. In addition, a contracting possibility with an exclusivity clause was available, upon prior publication of a technological offer statement, as defined in paragraph 1 of the aforementioned article.

Another important aspect that deserves to be highlighted in the contribution to technology transfer is that of joint development with a company, which can be contracted with an exclusivity clause, waiving a public offer, though the form of remuneration must be

established in an agreement or contract, guaranteeing greater legal certainty for both parties.

As provided for in paragraph 7, the remuneration received by the private STI for the technology transfer and the licensing for use or exploitation of usage, referred to in paragraph 6 of article 5, as well as that from research, development and innovation, does not represent an impediment to its classification as a non-profit entity. This legal provision guarantees security for such practices, since it does not mischaracterize the entity classification.

Also noteworthy is the possibility of providing specialized technical services by the STIs, in activities aimed at innovation and scientific and technological research in the productive environment, aiming, among other objectives, at greater competitiveness for companies, as established in article 8.

Regarding intellectual property, one of the bottlenecks of open innovation, the legislation anticipates the possibility of the STI entering into partnership agreements with public and private institutions to carry out joint activities of scientific and technological research and development of technology, product, service or process, however, it must anticipate, in a specific legal instrument, the ownership of intellectual property and participation in the exploitation results of creations produced by the partnership, assuring the signatories the right to use, license and transfer technology.

Still, another important aspect pointed out in the legislation is the fact that the STI may assign all intellectual property rights to the private partner through financial or non-financial compensation, as long as it is economically measurable. This possibility, together with those previously presented, represents an important advance in legislation, making the practice of cooperation more attractive for technology recipients, and guaranteeing legal certainty for all partners, facilitating research, development, innovation and transfer of technology process.

Conclusion

Although the new legal framework has brought several modifications, in order to reduce legal obstacles and provide greater flexibility and legal certainty in the promotion of innovation in the country, this chapter aimed to analyze three important regulations in the Decree regarding incentives for the development of cooperative projects involving companies, STIs and non-profit private entities; the constitution of legal personality by the CTIs; and the readiness for transferring public STI technology to the private sector.

As discussed in this chapter, Decree no. 9.283, by regulating various legal provisions establishing important incentive measures for scientific and technological research and innovation in the productive

environment, created and improved mechanisms to bring Scientific and Technological Institutions (STIs) and the production sector closer together, increasing the possibilities that research carried out at the academy reach companies, which drives the country's economic, technological and social development.

Open innovation practices prove to be effective for the development of qualified collaborative research, promoting greater articulation between academia and the productive sector, collaborating to consolidate a favorable environment to innovation. Universities, in recent years, have shown greater proximity to the production sector, and research is increasingly returning to this environment.

Decree no. 9.283, when dealing with strategic alliances in cooperation projects, demonstrates the importance of stimulating the construction of innovation environments. For the development of cooperative research involving companies, STIS and non-profit private entities, the support of autarchic, foundational, direct public administration, including regulatory agencies and funding agencies, is fundamental.

In addition to this support, as shown before, the CTIs play an important role in promoting innovation, monitoring the relationship with other institutions, ensuring institutional policies, strengthening relationships in collaboration projects. The possibility of establishing its own legal personality, in addition to providing greater legal certainty, allows operational activities to be carried out with greater flexibility and autonomy.

Success in alliances in cooperation projects depends on an effective connection, with good communication, relationships and respect for the culture of each of the organizations involved in the partnership. The legal framework brought greater security to the practice of research and development activities, which aim to generate innovative products, processes and services, and technology transfer and dissemination.

The third chapter of the innovation law, which deals with encouraging the participation of STI in the innovation process, underwent several changes due to Law no. 13.243 of 2016. Such changes, as presented, brought greater legal certainty in the practices of cooperation projects, assignment and licensing of intellectual property rights and technology transfer, creating a favorable environment for the consolidation of an environment of innovation.

Finally, the legal framework, as discussed, brought greater transparency and made the relationship between STIs and companies more appealing for the promotion of cooperative projects, contributing to the formation of research networks and the development of science, technology and innovation in the country.

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Socio-environmental sustainability in the principles of action of the Centers for Technology Innovation of Higher Education Institutions of the ACAFE System

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Introduction

The importance of Scientific, Technological and Innovation Institutions (STIs) in the innovation movement is undeniable, but instead of acting only in personnel training, basic and applied research and technology transfer, they still hold the responsibility for inserting sustainability in relations with the government and companies, which should then become a vector of action for the Technological Innovation Centers.

Thus, this article aims to point out whether the principles of action of the CTIs of the Higher Education Institutions (HEIs) of the ACAFE System observe sustainability criteria.

The role of the Technological Innovation Centers as the managing body of the Innovation Policy of Scientific, Technological and Innovation Institutions

In the cooperation between universities and companies, though both have benefits, the coexistence is the result ofthe approximation of two very different worlds, since, in sum, the first has its conduct normally guided by maturity, freedom and publicity, while the second is shaped by agility, meeting market needs and appropriation (PINTO, 2012, p. 105-106).

In this context, the current benefits of scientific advances, access to qualified labor and infrastructure, reduction of research costs and a good image in society are seen as benefits to companies.

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On the university side, we can observe the usefulness of research results, as well as new research problems that might even bring teaching closer to reality, and diversification of funding sources as benefits (PINTO, 2012, p. 106-107).

With regard to established forms of cooperation, the author highlights both informal relationships, in which consultancy and the generation of companies based on research results stand out (spin-offs), as well as formal ones, which include agreements that provide for scholarships, exchanges, training and joint research, as well as the involvement of liaison bodies between institutions; and even the creation of special structures such as incubators and technology parks (PINTO, 2012, p. 108).

The Innovation Law, i.e., Federal Law no. 10.973/2004, intended to leverage technological innovation in Brazil by encouraging interaction between companies and STIs, which becomes even clearer from the enactment of Law no. 13.243/2016, i.e., the law that established the New Brazilian Legal Framework for Science, Technology and Innovation (ST&I).

Among the strategies foreseen in the law for the development of this interaction, the head paragraph (*caput*) of article 16[1] indicates the determination that one or more ICTs create a Center for Technology Innovation, responsible for managing the innovation policy of these institutions.

Also, in paragraphs 3 to 5 of article 16 of the Innovation Law[2], which were also inserted by Law no. 13.243/2016, even allowed the creation of CTIs with their own legal personality, or the establishment of partnerships with existing entities, provided that, in both cases, the lucrative purpose of the legal entity is absent.

As noted by the National Union of Teachers of Higher Education Institutions (Sindicato Nacional dos Docentes das Instituições de Ensino Superior – ANDES-SN, 2017,26), this projection paved the way for carrying out activities without the control of the academic community and the university institution itself.

The consequence of this is that the activities of the CTI will have an even stronger tendency to concentrate direct demands from the industry, whose companies will control the research agenda and appropriate the benefits of projects developed, such as ANDES-SN (2017, p. 26-27) exemplified the case of the Brazilian Company of

1 Article 16. To support the management of its innovation policy, the public STI must have its own Center for Technology Innovation or one in association with other STIs.

2 Paragraph 3 The Center for Technology Innovation may be constituted with its own legal personality, as a private non-profit entity. Paragraph 4 If the Center for Technology Innovation is constituted with its own legal personality, the STI must establish management guidelines and ways of transferring resources. Paragraph 5 In the hypothesis of Paragraph 3, the public STI is authorized to establish partnership with existing non-profit private entities, for the purpose foreseen in the head paragraph (*caput*).

Research and Industrial Innovation (Empresa Brasileira de Pesquisa e Inovação Industrial – EMBRAPII), a social organization that receives federal public funds.

The Innovation Law itself establishes the attributions to be carried out by the CTIs, bearing in mind that these are only minimum jurisdictions, i.e., and that they can and must be expanded, according to the content of subparagraph IV of its article 2[3] and of § 1 of its article 16[4].

The first competence imposed by the Innovation Law on the CTIs is to manage the STI's innovation policy. However Alves, Amarante Segundo and Sampaio (2015, p. 690) highlight the paradox inserted in this task, insofar as there was no such policy in STIs. Hence the need for CTIs, first of all, to formulate proposals to create such a policy and disseminate it throughout the academic community, seeking the effective implementation of innovation policies in institutions that were not used to the matter.

This attribution and the others established up to subparagraph VI of paragraph 1 of article 16 of the Innovation Law have a more internal character, i.e., they are related to what happens within the STI, whereas subparagraphs VII to X, added by Law no. 13.224/2016, impel the CTIs to turn to the external environment, in order to evaluate, negotiate and finally transfer the knowledge generated within the ICT to companies that can implement such knowledge in the market and in society.

Therefore, it is observed that the new Brazilian legal framework for ST&I outlined the CTIs' performance to be more focused on economic development, which was already defended by scholars on the subject.

Based on the assumption that the flow of knowledge represents a process of inputs and outputs, Benedetti (2010, p. 9-12) analyzes that the CTIs are of fundamental importance, with regard to inputs, in identifying the possibilities of external promotion by government agencies and by venture capital companies, as well as identifying external demands to map internal research and collaborate with incubators in the development of new undertakings. From the

3 Article 2 For the purposes of this Law, what is considered a [...] VI - Center for Technology Innovation (CTI) is a structure instituted by one or more STIs, with or without its own legal personality, whose purpose is the management of the institutional innovation policy and, as minimum jurisdiction, the attributions foreseen in this Law;

4 Paragraph 1 The competencies of the Centers for Technology Innovation referred to in the head paragraph (*caput*), among others, are: I - to ensure the maintenance of the institutional policy to encourage the protection of creations, licensing, innovation and other forms of technology transfer; II - to evaluate and classify the results from research activities and projects to comply with the provisions of this Law; III - to evaluate the request of an independent inventor for the adoption of an invention pursuant to article 22; IV - to consider the convenience and promote the protection of creations developed at the institution; V - to consider the convenience of disclosing the creations developed at the institution, subject to intellectual protection; VI - to monitor the processing of requests and the maintenance of the institution's intellectual property titles; VII - to develop studies of technological prospection and competitive intelligence in the field of intellectual property, in order to guide STI's innovation actions; VIII - to develop studies and strategies for the transfer of innovation generated by STI; IX - to promote and monitor the STI's relationship with companies, especially for activities established in articles 6 to 9; X - to negotiate and manage STI's technology transfer agreements.

point of view of outputs, CTIs can contribute mainly to knowledge protection through patents and their subsequent licensing, as well as establishing partnership contracts and providing strategic support for startups.

Analyzing the Innovation Law, it appears that it is currently necessary for CTIs to be eclectic, adopting all these behaviors at the same time.

However, Arbix and Consoni (2011, p. 215) state that "[...] there are very few examples of CTIs that perform all the activities described and prescribed in the Innovation Law." Attributing this panorama partially to the newness of most Brazilian CTIs, the authors add that "[...] the most common thing is to find CTIs involved in conducting patenting and licensing processes, as well as intermediating projects with public or private companies."

In this regard, it should be noted that the establishment of centers became mandatory only with the advent of the Innovation Law, although some STIs already had these structures. The nomenclature is diversified, since, similarly to centers for technology innovation, there are innovation agencies, technology transfer offices and intellectual property centers (ARBIX; CONSONI, 2011, p. 207).

For Benedetti (2010, p. 2), "[...] the CTI appears as a moderating agent between the two spheres and, despite belonging to the academy, its management must be attentive to the approximation and understanding of the production sector mode of business management."

However, the lack of a legal personality imposed on the CTIs by the Innovation Law's original wording is cited as a determining factor for the failure of these structures to operate, since, due to this, they lack managerial, budgetary and human resource autonomy (RAUEN, 2016, p. 24).

Therefore, the amendment promoted by Law no. 13.243/2016 on this point is highly praised by economic development enthusiasts. As already mentioned, based on the new regulatory framework, the CTIs, in addition to having their attributions expanded to include strategic activities, now have the possibility of being autonomously constituted, i.e., with their own legal personality, both in the genre of private non-profit entities and specifically in the form of a support foundation (RAUEN, 2016, p. 31-32).

Lotufo (2009, p. 56) identifies three profiles adopted by the CTIs, depending on the activities they carry out. The first is revealed by those dedicated to regulating and formalizing contracts and patents, composed of lawyers and specialists in intellectual property. The second profile is that of CTIs that are limited to approving and forwarding agreements and contracts related to STI-enterprise interactions. And the third model is characterized by business development based on STI research results.

The same author also classifies the CTIs in another triad, analyzing them according to their missions: the first group seeks an extra source of funds for the university in royalties, another is aimed at regional development through technology transfer, and the last group is more concerned with benefiting society with the results of scientific research (LOTUFO, 2009, p. 56-57).

According to Trzeciak, Coral and Pereira (2010, p. 41), "[...] examples of different missions that CTIs can take on are guaranteeing society's access to the knowledge generated by STI, and maximizing the financial return on the generated intellectual property."

Therefore, CTIs are also part of a survival strategy for Brazilian universities, given the scenario of uncertainty regarding the economic sustainability of many Higher Education Institutions, largely due to the current competitiveness in the sector.

However, regarding the expected results of the CTIs, Alves, Amarante Segundo and Sampaio (2015, p. 694) warn that these should not be merely quantitative, i.e., guided by financial return, but above all qualitative, from the point of view of social development.

> The return that CTIs can offer to institutions is, above all, the fulfillment of a social gap, delivering to society the knowledge generated through them, in the form of solutions found for the diverse and complex problems that exist around them, duly protected when applicable. In this regard, the financial return must be understood as secondary in the creation of the CTIs, as it will be the instance in which t the interaction between the STI and the business environment will occur, enabling the complete fulfillment of the STI's purposes. As stated by Lita Nelsen, from the MIT Technology Licensing Office, this fulfillment does not reside in the revenue, but in the impact that these technologies can generate in society. (ALVES; AMARANTE SECONDO; SAMPAIO, 2015, p. 694-695).

As the CTIs occupy the central position of the triple helix[5], they will be able to move the other parts in accordance with socio-environmental sustainability criteria, including the fourth axis[6] which is capable of stopping all the others.

Thus, the center for technology innovation, as its name already suggests, is a figure of crucial importance for the technological innovation actors, with a strategic role both for economic development and for balancing innovation with respect to current demands for the promotion of social equity and environmental preservation and restoration.

5 A figure alluding to the constant influence that government, companies and universities exert on each other, and on society as a whole, in the performance of activities related to innovation (LEYDESDORFF, 2012).

6 The fourth helix in the innovation movement can be represented by the public based on culture and media (CARAYANNIS; CAMPBELL, 2009), by civil society (CARAYANNIS; GRIGOROUDIS, 2016, p. 37-38), users, society, public, and internationalization (LEYDESDORFF, 2012), and represents, for Rodrigues and Engelmann (2014), the concern with the socio-environmental impacts of innovations.

The Centers for Technology Innovation of Higher Education Institutions affiliated to ACAFE

The modification of the concept of STI promoted by Law no. 13.243/16 made it possible for not only Public Administration bodies and entities involved in research and development to benefit from its instruments, but also for private non-profit legal entities that have the same objective, such as Community Institutions of Higher Education (CIHE) with a strong presence in the state of Santa Catarina.

The obligations set forth in Law no. 10.973/04, in turn, seem more lenient for non-profit private law STIs. For example, article 15-A, added by Law no. 13.243/16, establishes only that the public law STI must institute its innovation policy. The same can be observed in relation to CTIs, which are mandatory, according to the STI legal framework, only for STIs governed by public law (article 16).

However, private STIs mirror the public system and already have many CTIs spread across the country, as well as innovation policies to guide their activities in this area. This data are revealed by the report based on the Form on Policies of Intellectual Property of the Institutes of Science, Technology and Innovation of Brazil (Formulário para Informações sobre a Política de Propriedade Intelectual das Instituições Científicas, Tecnológicas e de Inovação – FORMICT), which was filled out by public and private STIs that benefited from the public authorities in 2017, relative to the base year 2016.

According to the aforementioned report, of the 278 institutions that completed the FORMICT, 193 were public institutions and 85 were private institutions. Also, 71.5% of public institutions and 63.5% of private institutions reported that they have implemented an innovation policy. Still, 156 public institutions (80.8%) reported that they already have an implemented CTI, seven (3.6%) that did not and 30 (15.5%) that are in the process of implementation. In turn, 52 private institutions (61.2%) reported that they have an implemented CTI, 17 (20%) do not, and 16 institutions (18.8%) reported that their CTI is in the process of implementation (BRASIL, 2017, p. 9-14).

This scenario with significant participation of private STIs in the development of innovation, especially the Centers for Technology Innovation, is also found in the State of Santa Catarina, despite its Innovation Law not having received changes similar to those of the Brazilian legal framework – that is, in regional legislation, STIs remain conceptualized only as bodies or entities of the state public administration in charge of research[7].

7 State Law no. 14.328/08, Article 2 For the purposes of this Law, what is considered a [...] IV - Scientific and Technological Institution of the State of Santa Catarina (Instituições Científicas e Tecnológicas do Estado de Santa Catarina – ICTESC) is a body or entity of the Public Administration of the state of Santa Catarina whose institutional mission is, among others, to carry out basic or applied research activities of a scientific or technological nature;

The Santa Catarina Law of Innovation itself, after discriminating in subparagraphs I to VII of article 14[8] the attributions of the CTIs in a similar way to the original wording of Federal Law no. 10.973/04, in subparagraph VIII adds that they must act in line with other CTIs supported by FAPESC, which indicates that the government will also encourage non-profit private law STIs to promote innovation, including through the creation and improvement of CTIs.

Incidentally, shortly after the enactment of the Santa Catarina Innovation Law in 2008, with the aim of structuring and implementing the Santa Catarina arrangement of technological innovation centers, the Project for the Establishment and Development of an Agreement for Centers of Technology Innovation in Santa Catarina (Projeto de implantação e estruturação do arranjo catarinense de núcleos de inovação tecnológica – PRONIT) was planned. This project was approved in Public Notice MCT/FINEP/Ação Transversal – PRO-INOVA – 01/2008 (TRZECIAK; CORAL; PEREIRA, 2010, p. 3).

Thus, the Santa Catarina CTIs promptly received support for the formulation of their strategic planning, and the project involved several universities that are members of the Santa Catarina Association of Educational Foundations (Associação Catarinense das Fundações Educacionais – ACAFE), specifically: FURB, UDESC, UNESC, UNISUL, UNIVALI, UNIVILLE, Unochapecó and UNOESC (TRZECIAK; CORAL; PEREIRA, 2010, p. 3).

This reveals that the role of the CTIs in the development of innovation in the State of Santa Catarina is largely intertwined with the CTIs' performance of ACAFE member institutions.

According to its statute, ACAFE has the objective of bringing together and integrating entities that maintain higher education in the state of Santa Catarina, i.e., the educational foundations created by state law and Municipal Public Authorities, to promote administrative, technical and scientific exchange among HEIs, in the search for solutions to common problems in the areas of teaching, research, extension and administration (ACAFE, 2003).

Regarding the legal nature of the associated entities, according to Siewerdt (2010, p. 13), it is observed that, of the set of institutions currently affiliated, three are public under public law. One is a state

8 Article 14 the Santa Catarina Foundation for Research and Innovation (Fundação de Apoio a Pesquisa Científica e Tecnológica – FAPESC) will support ICTESCs to implement their CTIs, which will have the following attributions: I - organize and develop activities to support innovation in companies and institutions, particularly of regional importance; II - ensure the implementation, maintenance and development of the technological innovation institutional policy; III - meet and guide the demands presented by business sector and society for the practice of innovation; IV - participate in the evaluation of the results from research activities and projects to comply with the provisions of this Law; V - evaluate an independent inventor's request for adoption of an invention; VI - promote, in partnership with the competent bodies, the protection of creations developed in the institution and their maintenance and commercialization; VII - decide on the convenience of disclosing the creations developed at the institution that are subject to protection by intellectual property legislation;

institution, UDESC; and two are municipal, FURB and USJ. Of the three, FURB is the only one that whose education requires payment of tuition. The others were created by municipal law and are characterized in their legal nature as Public Foundations of Private Law.

The research sample (HEI of the ACAFE System) is justified by the fact that the educational foundations established in the state of Santa Catarina were very important for the dissemination of higher education in the state and, consequently, for regional development.

Until less than a decade ago, following the long history of concentration of Brazilian development only in its coastal region, only one federal university was located in Santa Catarina, in its capital, Florianópolis. Higher education in the countryside was the result of alliances between civil society and local public authorities that began in the 1960s (Lückmann; Cimadon, 2015; Siewerdt, 2010; Gumbowsky, 2013).

With the exception of institutions with a legal nature of public law that are part of ACAFE, the others can be characterized as CIHEs which, according to Law no. 12.881/2013, have, in summary, the following characteristics: a) they are constituted in the form of an association or foundation, with legal personality under private law, including those instituted by public authorities; b) their assets belong to civil society entities and/or public authorities; c) they are non-profit; d) they have administrative transparency; e) their assets allocation, in case of extinction, should go to a public institution or similar body.

It is also noteworthy, as Gumbowsky (2013, p. 89) reminds us, that the foundational Higher Education Institutions of Santa Catarina, "[...] gathered in the ACAFE, made use of their political strength, making the intrusion of private HEIs, whose main objective is profit, difficult."

Although they also do not have a profit objective, the federal STIs located in the Santa Catarina will not be the object of this study since they develop innovation in accordance with the legal framework and national policies, while "[...] the CIHEs create their strategies, focus on their mission and guide their purposes based on the local/regional area of their activities." (Lückmann; Cimadon, 2015, p. 73).

Furthermore, according to research carried out by Lückmann, Cimadon and Bernart (2015, p. 21) based on the 2012 Higher Education Census, the Community Institutions of Higher Education in Santa Catarina, which are the majority of those affiliated to ACAFE, were responsible for 126,541 enrollments in undergraduate education in the state, while public universities accounted for 48,459 enrollments, and private universities 138,505.

Therefore, it is also relevant to analyze its contribution to the promotion of innovation in Santa Catarina, and even more, of sustainable innovation, especially considering the express inclusion of socio-environmental sustainability in the Santa Catarina Innovation Law and in the State Constitution.

Furthermore, while at the federal level the policy for applying the Innovation Law is not clearly identified, in turn, the ST&I policy in Santa Catarina can be observed in a document prepared by the the Santa Catarina Foundation for Research and Innovation (FAPESC) and approved by the State Council for Science, Technology and Innovation (CONCITI) on September 11, 2009.

Equally since the Santa Catarina Innovation Law is explicitly linked to the constitutional principles that guarantee the improvement of living conditions in society, a commitment is established to observe the ST&I policy in the state together with social justice, life, human and environmental health, people's cultural values, the rational and non-predatory use of natural resources, the preservation and enhancement of the environment, the participation of civil society and communities, and the permanent incentive to the formation of human resources (Santa Catarina, 2010, p. 36).

Still, the support of research and technological innovations directed to the sustainable use of natural resources and the valorization of the environment is listed as a specific objective of the policy (Santa Catarina, 2010, p. 39).

Methodology

To meet the objective proposed in this chapter, HEI norms of the ACAFE System that contain the CTIs' principles of action will be analyzed, specifically the Statute, General Regulations, Research Policy, Innovation Policy and CTI Regulation.
However, data were collected from 9 of the 16 ACAFE institutions, namely: FURB, UDESC, UNESC, UNISUL, UNIVALI, UNIVILLE, Unochapecó, UNOESC and UNIPLAC. These entities adequately represent the sample population, based on numerous criteria verified by the researcher, as follows:

1. All are universities, since, in addition to teaching and outreach, they carry out research of a scientific nature; which, combined with the fact that they are constituted as public administration entities or as non-profit legal entities governed by private law, characterizes them as STIs;
2. With regard to most of them, the Innovation Policy had already been observed and evaluated in a previous study, from the perspective of the precautionary principle (PEREIRA; MIGOSKY, 2017);

3. For all 9 mentioned universities, information was found on the internet about the existence of the respective center for technology innovation, many having their own websites. In the case of UNESC, UNISUL and UNIVILLE, they also have technology parks, called, respectively, I-PARQUE, UNIPARQUE and INOVAPARQ. Another technological park located in an area covered by the STI component of ACAFE is Órion Parque, in Lages, but with no apparent direct connection with UNIPLAC, headquartered in the same city;
4. The institutions comprising the sample population delimited in this study, with the exception of UNIPLAC, were those that Trzeciak, Coral and Pereira (2010, p. 3) indicated as having actively participated in PRONIT;
5. The number of students enrolled in undergraduate courses at the universities actually surveyed corresponds to the vast majority of the total relative to ACAFE institutions, according to the most recent data found in its website, concerning the year 2013. Of the total of 139,006 registrations in the ACAFE System statistical data, base year of 2013, the sum of the numbers of the institutions focused (119,723) is equivalent to about 86.13% of that amount;
6. Nine institutions have campuses spread across all mesoregions of the state of Santa Catarina classified by the Brazilian Institute of Geography and Statistic;
7. The universities analyzed are also located in all metropolitan regions established by State Complementary Laws no. 475/2010, no. 523/2010 and no. 571/2012. Excepting the city of Rio do Sul, all the other seats of the metropolitan regions have a campus or even the headquarters of these HEIs.

The data collection, i.e., of the documents delimited in the specific objective of this research – Statutes, General Regulations, Research Policies, Innovation Policies and Regulations of CTIs – referring to the 9 HEIs that are part of the ACAFE System selected, took place by consulting the websites of the institutions and internet search engines, and also through electronic correspondence sent to the HEIs.

Socio-environmental sustainability in the principles of action of the CTIs of the ACAFE System HEIs

The analysis of the Statutes, General Regulations, Research and Innovation Policies and Regulation of the CTIs of the ACAFE System HEIs showed that the principles of action of their CTIs do not observe socio-environmental sustainability criteria, as seen in Chart 1.

Chart 1. Conclusions drawn from analysis of documents of each HEI

Institution	Conclusions
UDESC	The Statute stipulates principles and purposes that refer to socio-environmental sustainability. The General Regulation is neutral. The innovation policy only mentions economic sustainability and greatly encourages production science[9], given the revenue-sharing format obtained with innovation. The CTI Regulation lists the same attributions contained in the Federal and State Innovation Laws.
FURB	The Statute stipulates that the university's mission is to carry out actions related to socio-environmental sustainability. The General Regulation is neutral. Research policy confuses sustainability with economic growth and fails to predict the allocation of resources from *royalties* for impact science. The innovation policy and the CTI attributions foreseen therein encourage only production science and assume that economic growth will leverage social development.
UNIVALI	The Statute stipulates principles, purposes and objectives that refer to socio-environmental sustainability. The General Regulation is neutral. Research policy prioritizes economic growth. The research and innovation policy and the CTI regulation provided for subordinate environmental sustainability to economic sustainability and greatly encourage production science, given the format for sharing revenues obtained with innovation.
UNIVILLE	The Statute and the General Regulation contain objectives without clear content, so they can be easily manipulated, as well as the term sustainable development. Research policy predicts a weak, or even very weak, sustainability concept.[10]
UNISUL	The Statute does not even contain principles related to socio-environmental sustainability. The General Regulation makes an explicit relationship between research and innovation. The research policy provides principles of socio-environmental sustainability but, in a contradictory way; establishes the primacy of economic growth and the idea that this, by itself, will leverage social development. Intellectual property policy addresses no issue other than the management of intellectual property. The CTI Regulation lists the same attributions contained in the Federal and State Innovation Laws.
UNESC	The Statute stipulates numerous mission precepts, values and principles related to socio-environmental sustainability, as well as establishing these pillars as a research priority, which is reinforced by the General Regulations. The research policy institutes general themes that converge to socio-environmental sustainability. The innovation policy mentions these pillars in its objectives, but alongside economic objectives, evidencing a weak concept of sustainability. The CTI's regulation subordinates sustainable development to economic growth and repeats the attributions already contained in the Federal and State Innovation Laws.

9 Production science leads to increases in production, distribution, and consumption of goods and services (including military) that increase profit. Whether it is basic science or applied science, production science aims to generate results. These can come in the form of new consumer goods, new weapons systems, new production processes or new materials (SCHNAIBERG, 1980 *apud* GOULD, 2014, p. 36).

10 Veiga (2010, p. 39) defines the concept of sustainability as one "[...] which takes as a necessary and sufficient condition the rule that each generation bequeaths to the next the sum of three types of capital considered entirely interchangeable or replaceable: the proper one, the natural/ecological one, and the human/social one." In Cechin and Veiga's metaphor (2010, p. 39), "[...] it is as if more cakes could be made by doubling the number of mixers and bakers, without needing additional amounts of flour, eggs and sugar."

UNIPLAC	The Statute stipulates principles and purposes related to socio-environmental sustainability, but also establishes economic growth as an objective, evidencing a weak concept of sustainability. The General Regulations only repeat some precepts of the Statute related to socio-environmental sustainability.
UNOESC	The Statute establishes objectives referring to all pillars of sustainability, evidencing a weak conception of sustainability. The General Regulations are neutral. The research and innovation policy confuses sustainable development with economic growth, i.e., in a very weak sustainability perspective. The attributions of the CTI are the same as those contained in the Federal and State Innovation Laws.
Unochapecó	The Statute stipulates purposes referring to socio-environmental sustainability. The General Regulations are neutral. Research policy confuses sustainability with economic growth. The intellectual property policy greatly encourages production science, given the format for sharing revenues obtained with innovation. The CTI regulation repeats the attributions already contained in the Federal and State Innovation Laws.

Source: by the authors (2022).

The normative structure of ACAFE System HEIs in terms of innovation is similar to that originating from the public power. There is a fundamental norm enunciating important socio-environmental principles and subjecting ST&I to them (in the case of the Constitution of the Republic, the State Constitution and the Statutes and General Regulations of HEIs).

At a lower level, there are other norms deviating from fundamental dictates (as in the case of the Brazilian ST&I legal framework, most research and innovation policies and the totality of CTIs Regulations), or just formally reproducing them without establishing measures for its implementation (as in the case of the Santa Catarina Innovation Law), or even being contradictory due to mentioning the need to care for society and environment, and, at the same time, promoting concrete measures aimed only at economic growth (such as in the case of some of the research and innovation policies).

Conclusion

In view of the absence of socio-environmental sustainability criteria in the CTIs performance principles of the ACAFE System HEI, it is to be expected that, in their day-to-day activities, the CTIs are not guided by any of these pillars, or, at most, that they consider them as measures equivalent to economic sustainability.

The analysis of the effective performance of the CTIs can be the object of future investigation, using a methodology that allows the researcher's immersion in these environments.

In any case, this research revealed a very important aspect: the norms that universities edited encouraging innovation were built in accordance with the call to leverage economic growth, in the same way as the legislation that deals with the subject.

Universities could, however, regulate differently about the development of innovation. Measures such as the largest investment in impact science[11], or the obligation that, in carrying out production science, there should be a simultaneous assessment of the risks of innovation under development, would be consistent with university autonomy and, also, with the fundamental right to a balanced environment.

Likewise, the forecast of greater investment or scientific merit for projects dedicated to technological innovations that increase environmental conservation and the enjoyment of social rights, as well as the constitution of funds for resources allocation obtained from production science, destined to impact science, would be essential criteria to align CTIs performance with the true meaning of sustainable development.

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11 Impact science is science that increases our understanding of the environmental and health impacts of production processes, products and externalities. Impact science aims to observe changes in the natural environment and human health that derive from social additions and withdrawals from ecosystems (SCHNAIBERG, 1980 *apud* GOULD, 2014, p. 36).

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A proposal for improvement and study of companies incubated in technology centers, in Santa Catarina, according to the *Safe by Design* tool

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Introduction

There is no doubt that the innovation ecosystem is necessary in promoting social, economic and cultural development. It is only through responsible research and innovation (RRI) that more sustainable production can be achieved, consistent with the UN's 2030 Agenda.

Regarding the impacts and expansion of technological advances, the so-called Fourth Industrial Revolution (SCHWAB, 2016) brought historic changes in terms of size, speed and scope. The consequences of these transformations, their complexity and interdependence are still unknown. But what is known is that all stakeholders in global society – government, business, academia and civil society – have a responsibility to work together to better understand these emerging trends, as well as to deal sustainably with the risks of these innovations.

The risks[1] are largely unknown and future damages are uncertain, but the decision needs to be made in the present, through the use of these new tools that emerged through the incorporation of the idea that knowledge can no longer be imprisoned in the hermetic limits of each field of knowing.

Hence, now is the time to observe and build legal models permeated by both certainty and uncertainty in relation to social expectations that are continually frustrated/satisfied by ever-increasing social complexities (ROCHA; MARTINI, 2016).

The transformations brought about by innovations in today's society are greater than can be predicted, and even deeper and faster than at any other time. Thus, the current scenario presents itself as a challenge for further analyses, studies and research.

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1 "In traditional literature, risk is accompanied by reflections on 'safety'. From this perspective, Luhmann prefers to place risk in opposition to 'danger', understanding that social events are caused by contingent decisions (they could be different), which no longer allow us to speak of a safe decision." (Rocha, 2013, p. 24).

In this context, this chapter proposes the application of questionnaires to innovative companies incubated in the Technology Centers in the state of Santa Catarina, aiming to understand the realities of each one, and their challenges facing current world aspects (fragile, anxious, non-linear and incomprehensible) in search for the consolidation of Sustainable Development Goal 12 (SDG 12 – sustainable production and consumption) and verifying the possibility of applying Safe by Design in their production processes, whether the final object is a product or a service.

Therefore, this chapter is divided into an introduction, where the proposal is presented within the current context of innovation; a contextualization and conceptualization part, aiming to demonstrate the concepts on which the proposal is based (sustainability, responsible research and innovation, sustainable development goals, Safe by Design); a presentation of the proposal to improve the technology centers in view of future challenges; and a conclusion, where final considerations are made, remembering François Ost (1995, p. 389) who mentions that it is necessary "[...] above all, not to conclude, resisting the temptation of the last word, that point made at the end of pages accumulated. Rejecting that reassuring desire for closure, judging everything together." Thus, the proposal presented here is just one more step on the road to the necessary transdisciplinary reflection on the possibilities and challenges generated by technological innovations.

Contextualization and conceptualization

When talking about more sustainable production, all aspects involved are considered.

According to Freitas (2012, p. 16):

> [...] sustainability is an intergenerational commitment: (a) with equity; (b) with the pricing of inoperability, which has allowed the undue externalization of environmental costs; (c) focusing on renewable energy and the low-carbon economy; (d) with 'environmental modernity', without damage to long-term solutions; (e) with the adoption of indicators able to assess the quality of public and private policies; (f) with the prospective thinking of prevention and precaution, which significantly expands constitutional control, and significantly expands constitutionality control; and (g) with a renewed systematic logic, which does not contemplate, separately or in a fragmented way, the environmental, economic, ethical, legal-political and social aspects.

Furthermore, as for sustainability, it is important to mention that, as an open concept, what is considered sustainable at a period of economic crisis may not be at another time. Thus, each historical moment has to be considered, especially in issues related to

production and consumption models.[2] “This fact demands reflection on new perspectives, rediscoveries and reinforced links between the human and non-human elements that belong to the common home.” (BODNAR; FREITAS; SILVA, 2016, p. 65).

It can be said that, in a future perspective, the conservation of the planet will require much more than knowledge of the countless and different social systems, innovative technology and methods of reducing waste: it will demand, in addition to attention to all these aspects, a behavioral change for everyone, whether they are producers or consumers.

In this sense, the principle of sustainable development, expressed in the Brazilian constitutional text, must guide the achievement of objectives and the right to development, combined with the conservation and maintenance of an ecologically balanced environment. The principle of sustainable development is known as the principle of eco-development or sustainable development, or even sustainability, and is included in the Brazilian constitutional text, in article 170, subparagraph VI.

2 The consumer market is more fragile because of the pandemic. People are more interested in their impact, buying more locally to help businesses and individuals closer to their communities. Consumer sensitivity is heightened, with companies and the public sector in the spotlight, demanding more responsibility for their actions and recovery plans, which is applauded or mocked. This does not mean that consumers now have a complete understanding of sustainability, but the conversation is back on the table like never before. People are now also concerned about social impact, not just the environment (SHULLA, 2021).

The concept of sustainability was definitely incorporated as a principle during the United Nations Conference on Environment and Development, the 1992 Earth Summit – Eco-92, in Rio de Janeiro. Seeking a balance between environmental protection and economic development, it was the basis for the formulation of Agenda 21, to which more than 170 countries committed themselves at the conference.

It is a comprehensive set of goals for creating a world that is, in short, balanced. The 2002 Policy Statement of the World Summit on Sustainable Development, held in Johannesburg, states that sustainable development is built on three interdependent and mutually supportive pillars – economic development, social development and environmental protection. The International Implementation Project (IIP) presents four main elements of Sustainable Development – society, environment, economy and culture.

When mentioning responsible research and innovation, the concept of RRI is referred to: Responsible Research and Innovation. By its very nature, RRI represents a functional definition that allows for broader investigations and deliberations. Thus, it can be said that RRI is a broad term that includes a variety of notions. Such notions share a common point, all of which seek to implement responsible practices in research and innovation. It is a transparent and interactive process that aims to become responsive to mutual need, i.e., a vision of ethical acceptability, sustainability and social desirability of the innovation

process and its marketable products is developed (HULLMANN, 2008).

The socioeconomic development occurring with the advent and implementation of new technologies in the most diverse production processes cannot fail to consider ethical, legal and social aspects, as well as sustainability, always promoting the ideals of planetary responsibility and environmental non-regression.

These technologies are no longer just futuristic promises and are incorporated into the daily routine of society at the beginning of the 21st century, therefore demanding attention from the field of law. However, many of these new technologies are accompanied by scientific uncertainties regarding their effects and future damage to the environment and to human life.

The Fourth Industrial Revolution, which has been under way since the turn of the century, comprises technological innovations such as artificial intelligence, robotics, the internet of things, autonomous vehicles, 3D printing, nanotechnologies, biotechnologies, energy storage and quantum computing. What distinguishes it from the three previous revolutions is its speed, breadth and depth, in addition to the fusion of technologies and the interaction between the physical, digital and biological domains, generating unprecedented paradigm shifts not only in the economy, but also in society and individuals. Still, it involves the transformation of entire systems among and within countries, in organizations, industries and throughout society (SCHWAB, 2016).

The development of these new technologies, whether products or services, resulting from the Fourth Industrial Revolution, generates important ethical, legal and social impacts, also related to the principle of precaution and information, as well as reflections on labor relations and the environment. There is no way to imagine scientific and technological advances, as well as economic ones, based on social regression in areas of health and protection. For the law to be able to deal with the challenges brought about by the advances in new technologies arising from the Fourth Industrial Revolution, it must open up to two paths: expanding to other areas of knowledge that can help it understand the complexity of the realities that these innovations will make possible and letting ideas come in from other areas and knowledges. This will be the condition of possibility for innovation in/of the juridical in the Age of Innovation.

Thus, the advancement of technologies in a growing set of applications begins to integrate the daily life of Brazilian and world society. On the other hand, research and products that will result from this human intervention in natural forces will require the action

of different systems[3], with the assessment of emerging social, ethical and regulatory impacts, supported by an innovation model that should be responsible and sustainable, since there is uncertainty regarding the risks of these new technologies.

The legal system needs an approach based on transdisciplinarity in order to contribute to the achievement of the UN's sustainable development objectives, in a current scenario permeated by the BANI characteristics replacing the VUCA world (volatility, uncertainty, complexity and ambiguity). It is worth remembering that since 2020, largely due to the coronavirus pandemic, with global and systemic alterations, these current world characteristics have changed to BANI (brittle, anxious, nonlinear and incomprehensible).

In view of the countless new challenges that emerged with the Fourth Industrial Revolution, it is clear that, since law is an applied social science, the production of its knowledge must always be contextualized, based on problematized situations in society and not just be restricted to theoretical digressions without any connection with the factual world (GUSTIN; LARA; COSTA, 2012).

It is essential that we turn our eyes to researching the changes that the law needs, in order to prepare its professionals to deal with the BANI, which translates the conditions of the current world, as Pontes de Miranda appropriately mentioned in 1922,

> [...] those who scan, on the one hand, the progress and conquests of the physical sciences and, on the other, those of the social sciences, cannot help but feel sad. Law continues to be elaborated and explained according to the methods of Roman times and the Middle Ages. (PONTES DE MIRANDA, 1972, p. 19).

With this context in mind, the idea explored in this chapter is a way of applying questionnaires to innovative companies incubated in Santa Catarina's technological centers, seeking to access the realities of each of them and the challenges they face in a BANI world in pursuit of achieving SDG 12, which deals with sustainable production and consumption, verifying the possibility of applying Safe by Design in its production processes, whether the final object is a product or a service.

Safe by Design approaches intend to redesign and refine routines and/or the production of innovative materials aimed at mitigating their potential risks, maintaining the desired properties that make them attractive for various purposes. This involves a) identifying the characteristic(s) that make innovative products/services potentially risky; b) the assessment of desired properties and how they are

3 "In today's society, we see an approximation between the political, economic and legal order. This approximation does not mean that the systems do not have their autonomy, on the contrary, we can see the constant need for a greater cognitive opening linked to an operative closure, because only then can society be analyzed as a communication mesh." (ROCHA; MARTINI, 2016, p. 25).

correlated with identified material capabilities; and c) redesigning production strategies whether for materials or services.

With the use of design strategies, there is a real possibility of mapping and controlling exposure and potential risks, even mitigating occupational risk, in addition to risks to consumers. And here, when talking about risks, one thinks about all the possible risks that could harm the most different aspects of products/services sustainability. From this point of view, Safe by Design is more of a risk management approach than a risk assessment approach. Still, Safe by Design is expected to reduce risk and exposure to an acceptable risk level without affecting material performance, as well as guide the development of safer products and services at different stages.

When referring to different stages, what is meant is the necessary assessment of the entire life cycle of the products/services offered. The idea is to assess the risks throughout the lifecycle of products/services, from the cradle to the grave, case by case, so that both production and sustainable consumption are made feasible, in order to honor the responsibility for the future of the environment, quality of life and intergenerational equity.

The expected impact is that Safe by Design be used from the initial phase of the development processes of new products/services; that workplaces improve quality and ensure maximum economic performance in line with acceptable risk levels; that there is control and mitigation of exposure to an acceptable risk level; and that low-cost techniques are developed and validated in carrying out an integrated exposure-oriented risk assessment and the design associated with the necessary post-use monitoring, whether of products or services.

The possible main benefits for an entrepreneur who uses this tool can be characterized as: the reduction of the time required for research and development of products/services, since safety is considered from the beginning; the economic issues; the effective cost of innovation; the greater speed of elaboration of the product/service to be launched on the market, since, throughout the entire product, development safety aspects were considered; the elaboration of safer and more sustainable products/services, that are therefore better accepted by the consumer market; as well as the readiness for future regulatory challenges, since the best available technique was used.

Thus, these principles will need to be tested and reconsidered over time to help guide product designers to make better informed and effective decisions for the safety of the products/services offered. In addition, there is a clear need for evaluation throughout the product/service life cycle and on a case-by-case basis.

A proposal for improvement in the face of future challenges

Hence, the proposal is to carry out, through research application, a verification of the possible contributions of the Safe by Design tool in companies incubated in Santa Catarina Technology Centers, as a way to unite the System of the Law and the System of Science. The aim here is sustainability, in its different aspects, applied to innovation, in the context of the Millennium Development Goals projected by the United Nations (UN) until 2030 (especially SDG 12 – sustainable consumption and production).

Furthermore, as a secondary but no less important aim, Law students would be provided with contact with innovation and entrepreneurship. In addition, this would lead to the development of research in transdisciplinary contributions, developing the necessary skills for all current and future professionals in this context permeated by BANI characteristics.

The idea is to map out the companies incubated in Santa Catarina technology centers, and to prepare a questionnaire based on bibliographical research, aiming to understand their work and production routines and the possible use of Safe by Design as a way to achieve SDG 12.

Subsequently, semi-structured interviews will be carried out, with the help of scholarship students from state law schools, with innovative companies incubated in the technology centers in order to understand their production routines and verif the feasibility of using Safe by Design as a tool to improve product and service development processes, from their creation to the end of their cycle, hence, aiming to comply with the provisions of SDG 12, in relation to more sustainable production.

With this activity, law students would be in contact with new perspectives, as well as innovative and entrepreneurial ideas that are often not found in law schools (unfortunately).

Thus, the objective is also to instill in law students a transdisciplinary perspective, as one of the many soft skills that are so much in need in today's market. When mentioning soft skills, we include teamwork skills, oral and written communication, ethics, time management skills, problem solving, critical thinking, and leadership. These basic skills are usually further developed through active student participation.

Hence, it would be possible to unite the needs of the innovation sector with the adequate preparation of law students to face the challenges that new technologies bring on a daily basis to the science of law; challenges that do not have ready answers in codes, laws and other existing normative instruments.

Moreover, this is how the practical application of the necessary transdisciplinarity required by the contemporary world is carried out, in an attempt to create possible solutions to the new problems generated by new technologies resulting from developed innovations.

Conclusion

The idea presented here is to demonstrate the possibilities of integrating law, technology and innovation, also giving incubated companies the opportunity to participate in a global discussion, with local interfaces, in pursuit of the UN's Sustainable Development goals, more specifically, the SDG 12 – sustainable consumption and production – in order to cover aspects of the current scenario permeated by volatility, uncertainty, complexity and ambiguity.

The aim is to bring in law mechanisms to deal with current complexities, through transdisciplinarity, seeking to understand the complexity of contemporary legal relations and also the social function of the law, verifying the possibility of using the Safe by Design tool in the production routine of companies incubated at centers, aiming to comply with the SDG 12.

Even if many companies are service providers or application developers, for example, the practices used in the day-to-day routines of these organizations can still be mapped to incorporate Safe by Design in all developed stages and processes.

Additionally, as possible expected results, the aim is to include the law and its sources in the scenario of technological innovation, proposing new risk models, including Safe by Design, and enabling the legalization of technological facts and the challenges they bring to a current scenario.

The way in which new technologies are capable of altering life in society, increasingly with greater intensity and speed, leads to the conclusion that "change is the only constant".[4]

Today, the expectation is to educate new consumers and producers on a lifestyle in harmony with nature, on choices and actions that minimize the use of natural resources and the generation of emissions, waste and pollution, while seeking sustainability in its broad sense. Creating sustainable lifestyles requires a shift in social, political and infrastructure design; it means rethinking ways of life, production and consumption, and how everyday life is organized. It is also about changing how we socialize, exchange, share, educate and build identities.

4 This sentence serves as the subtitle for chapter 19 of the work "21st lessons for the 21st century", by Yuval Noah Harari (2018, p. 304-305).

Finally, remembering what was mentioned in the introduction, the suggestion briefly presented here is a small step in a long and tortuous path on the management of innovations, to ultimately achieve the necessary sustainability for current and future generations and increasingly avoid environmental and social setbacks, seeking to consolidate not only the SDG 12, but the entire Agenda 2030, without leaving anyone behind.

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Proposals for improving Santa Catarina's science, technology and innovation policy based on the national regulatory framework

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Introduction

Since its enactment on October 5, 1988, the text of the Federal Constitution has not been concerned with establishing guidelines for innovation.

Article 218, at the time dedicated to science and technology, entrusted the State with promoting and encouraging scientific development, research and technological training. Its paragraphs guaranteed priority treatment by the State to basic scientific research (paragraph 1), aimed at solving Brazilian problems and the development of the national and regional productive system (paragraph 2).

The article required the State to support the training of human resources in the areas of science, research and technology (paragraph 3) and give incentives to companies that invested in research, creation of appropriate technology for the country, training and improvement of human resources and that also practiced remuneration systems that would ensure employee participation in the economic gains resulting from the productivity of their work (paragraph 4).

Paragraph 5 of Article 218 also allowed the States and the Federal District to link a portion of their budgetary revenue to public entities to promote teaching and scientific and technological research.

A simple consultation of the term innovation in searching for applications installed on digital readers, reproducing the original text of the 1988 Federal Constitution, and the search result being equal to zero, are enough to prove that innovation was far from the concern of legislators who composed the National Constituent Assembly. This scenario remained the same until 2015.

In the period between the promulgation date of the original constitutional text and the day of approval of Constitutional

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Amendment no. 85/2015, the infra-constitutional legislative activity and the publication of sectorial regulations was not at a standstill. Laws to encourage technological innovation and regulatory decrees were enacted at the federal, state and municipal levels.

The fact that, since 2004, Brazil has a law dealing with incentives for innovation and scientific and technological research in the productive environment; that the state of Santa Catarina passed, in 2008, Law no. 14.328, which now establishes measures to encourage scientific and technological research and innovation; and, that, three years earlier, as reported by Junckes and Teixeira (2017), the city of Luzerna, a small town located in the midwestern region of Santa Catarina, which at the time had a little more than five thousand inhabitants, sanctioned Law no. 615 of October 20, 2005, creating the first municipal economic development policy and establishing the granting of economic and fiscal incentives for companies that settled, expanded their production capacity, or advanced technological development and innovation projects; is an example of the mismatch between the constitutional, the legislative and normative treatment given to the theme.

That asynchrony has not influenced the path taken by the three entities composing the federation towards indicatingits potential – or absence of – to become a great player in high technology and innovation sectors.

Limiting, however, the analysis to the field of law, considering the symbolic character exercised by the constitution and, mainly, its prominence over other normative orders, the gap required deviations from the moment the theme was constitutionalized.

In other words, since 2015 the scenario calls for the adequacy of state, district and municipal constitution and legislation texts to the new guidelines inserted in the Brazilian Constitutional Amendment no 85.

Questions relating to the advantages and disadvantages of the constitutionalization process are tempting. On the one hand, romanticized views on innovation tend to link it to the inventive capacity, genius and creativity of human beings. In this case, the regulatory activity would act a priori as a brake on the sphere of freedom of thought and expression that should ultimately be the driving forces behind innovation. On the other hand, the central role that innovation processes have acquired in knowledge-based economies and the socio-environmental risks associated with them would justify state actions that seek to guarantee a safe and transparent legal environment to attract the interests of investors in high tech sectors. And, since the constitution occupies the apex of the state legal systems, nothing better than treating “innovation activities” from the top to, thereby, guarantee consistency to the regulatory base.

Despite the importance of this debate, in line with the body of work that this chapter presents, the theme is limited to how the state of Santa Catarina and its municipalities can adapt their legal systems to the dictates of the federal legislation on innovation, thereby complying with the ruling constitutional precepts. It is assumed that the hypothesis of the jurisdiction regime established in the Federal Constitution allows federal entities to "innovate" by supplementing and complementing Union legislation that deals with innovation.

To this end, the present chapter begins with a topic dedicated to the jurisdiction regime adopted by the Federal Constitution of 1988. Then, the constitutional guidelines of what has been called the right to innovation are discussed. Afterwards, it deals with aspects of the federal innovation legislation. Proposals for improving legislation in Santa Catarina and its municipalities close the text.

Characteristic of the jurisdiction regime established in the 1988 Constitution of the Federative Republic of Brazil

Understanding the jurisdiction regime adopted in the Federal Constitution of 1988 involves, first of all, understanding its structural, organizational and legal functions.

For Zanco, Mello and Pereira (2020, p. 80-82), the spatial organization form of power adopted by the Constitution and the federative pact depend on the jurisdiction divisions to properly function.

Contrary to the North American experience, in Brazil power has historically emanated from the center to the parts. It was not autonomous states that abdicated their sovereignty in favor of their Union, it was the Union that delegated powers and attributions to the federated states, which imposed the adoption of mechanisms to reduce the centrifugal degree present in the construction of the Brazilian State, making the harmony between the entities that constitute the Federation possible, reducing their powers and homogenizing them.

Thus, in addition to organizing the functioning of the State (organizing function) and limiting State power in relation to individuals (legal function), the allocation of competences seeks to equalize the powers between entities (structural function), truncating the adopted system, since the decrease in historical centrality faces, among others, political, organizational, legal and cultural resistance (ZANCO; MELLO; PEREIRA, 2020, p. 81).

Such factors delimit the general principle that regulates the division of powers between the entities composing the State to that of the predominance of interest, making matters of national interest fall within

the Union jurisdiction; matters of regional jurisdiction fall within the state jurisdiction and matters of local interest to the municipal one.

Based on this principle, jurisdictions are generally classified according to their nature or according to the attributions they confer on each entity of the federation (classification that takes into account the character of extension). As for the nature, the jurisdictions can be executive, administrative and legislative.

Executive jurisdictions determine the guidelines, strategies or policies for exercising power. The administrative ones focus on the aspects of implementation and inspection of measures based on command-and-control instruments and the legislative jurisdictions take care of the possibilities of each entity to legislate on the most diverse aspects (MINATTO, 2008).

As for the extension, the competences are classified as: i) exclusive: attributed to a single entity of the federation, with no possibility of delegation or supplementation (articles 21 and 30, both of FC/88); ii) private: assigned to a single federative entity (Union and Municipalities), but allowing delegation via Complementary Law (article 22, sole paragraph of FC/88); iii) common: attributed to all federation entities (FC/88, article 23), in this case, the one with the more rigorous character always prevails, or the one that better protects the legal good that it aims to guard; iv) concurrent: attributed to the Union and the states, with the Union having to limit itself to the establishment of general rules and the states (and the Federal District) having the prerogative to supplement the said general rules, i.e., to adjust the general rules to their realities (article 24, paragraph 1). Municipalities, whenever local interest is present, may also act in a supplementary manner, pursuant to article 30, II of FC/88. In cases of concurrent jurisdiction, Union rules are hierarchically superior.

In the words of Minatto (2008), because "[...] one classification does not exclude the other, and one adds to the other [...]", there are exclusive executive powers destined to the Union (article 21 of FC/88) to the states (FC/88, article 25, paragraphs 1, 2 and 3) and to the municipalities (article 30, VIII and IX of FC/88); common administrative jurisdictions (FC/88, article 23); exclusive legislative jurisdictions belonging to the Union (article 22 of FC/88) and to the municipalities (FC/88, article 30, I), supplementary powers destined to the municipalities (article 30, II, of FC/88), exclusive of the Union (FC/88, article 22) and concurrent, exercised by the Union, states and Federal District (article 24, of FC/88).

There are authors who add to the jurisdictions above, when treated in relation to the extension, the residual ones not attributed to the Union or the municipalities (FC/88, article 25, paragraph 1º) and, for that reason, belonging to the state members of the federation.

By allowing the crossing of classifications by more than one criterion, the jurisdiction system presents a degree of difficulty in understanding

that is aggravated by doctrinal and jurisprudential divergences on various aspects, definitions and concepts, for example, the concurrent legitimacy based on the federal entities autonomy of the will to establish rules, valid for their territory, that meet their peculiarities.

As Zanco, Mello and Pereira (2020, p. 82) point out, there are several unresolved issues regarding jurisdiction regimes, which continue to be the subject of discussion by doctrine and jurisprudence, in particular those related to: i) the criteria used to resolve conflicts when there is discrepancy between degrees and levels of protection of rights in cases of common jurisdiction; ii) divergences between federal, state and municipal legislation, in those cases of concurrent jurisdiction in which the indicated solution criteria in the paragraphs of article 24 of the Federal Constitution of 1988 are insufficient or poorly understood, especially concerning the following question: why can the states and municipalities only be able to supplement the federal legislation above the protection level of the guarded legal asset established by the Union?; and the definition of local interest in the case of municipalities.

As science, technology and innovation became part of the list of matters subject to the common jurisdiction regimes (article 23 of the Federal Constitution of 1988) and concurrent jurisdiction (article 24 of the Federal Constitution of 1988) only in 2015, the foundations of jurisprudential understanding have to be found in decisions involving issues related to other areas that receive similar constitutional treatment. Among them, the one related to environmental law has stirred the Courts the most in recent years.

Regarding the common jurisdiction regime, the arguments involving overlapping of environmental agencies with similar attributions were alleviated with the approval in 2011 of Complementary Law no. 140 that established norms, pursuant to subparagraphs III, VI and VII of the head (*caput*) and the sole paragraph of article 23 of the Federal Constitution, for cooperation between the Union, the states, the Federal District and the municipalities in administrative actions concerning the protection of remarkable natural landscapes, the protection of the environment, the fight against pollution in any of its forms and the preservation of forests, fauna and flora.

The adoption of a similar measure for the STI sector would be welcome.

In terms of competing jurisdictions, in the environmental area, the issue is more complex.

For problematization purposes, since not everything that applies to innovation law is valid for environmental law and vice versa, following the analysis of the concurrent jurisdiction regime, Zanco, Mello and Pereira (2020, p. 81) explain that the lack of clarity as to the scope of the principle of the predominance of interest, mainly the meaning of

"interest", causes states and municipalities, in most cases, to bungle and adopt mistaken changes, in most cases, turning the federal legislation pliable and causing a series of legal aberrations, for example, allowing cockfights and "farra do boi" (the practice of cruelly provoking and hurting bulls) in the Santa Catarina; the "vaquejada" (the practice of knocking over bulls as a competition) in the state of Ceará, and the possibility of small farmers planting crops at a distance of five meters from water courses, also in Santa Catarina; all arbitrary to the applicable constitutional commands, as declared by the Federal Supreme Court, when it had to manifest itself on lawsuits claiming direct unconstitutionality proposed to jettison and render the aforementioned legal provisions null and void, as well as so many other "attempts" that persist in denying the obvious, which was very well summarized by Celso Antônio Pacheco Fiorillo (2019): within the scope of concurrent jurisdiction, the Union fixes the "floor level" while the other entities do the "ceilings".

The divergent understandings of Brazilian courts regarding the possibility of municipalities restricting activities permitted by federal or state legislation generate more noise in the regime of spatial distribution of Brazilian state power.

So much back and forth and the multiplicity of divergent positions regarding municipaly jurisdiction to prohibit, for example, the burning of sugarcane, or completely prohibit or establish defined seasons or zones for the application of pesticides seem to indicate that the concept, definition and limits of "local interest" in the environmental field are far from being settled (ZANCO; MELLO; PEREIRA, 2020, p. 81).

When judging, in 2015, Extraordinary Appeal 586.224/SP, filed by the State of São Paulo and by the Industry Union of Alcohol Manufacturing of the State of São Paulo (Sindicato da Indústria da Fabricação do Álcool do Estado de São Paulo – SIFAESP) against the City Council and the City of Paulínia, through which the appellants intended – and managed – to obtain the reform of the decision of the São Paulo Court of Justice and the declaration of the unconstitutionality of the Law of the City of Paulínia 1952/1995, which had prohibited the burning of sugarcane straw and the use of fire in agricultural activities – considered the leading case regarding the legislative jurisdiction of the municipalities -, the Supreme Federal Court (SFC) delimited the designation "local interest" contained in item I, of article 30 of the Constitution of the Federative Republic of Brazil of 1988.

According to the SFC: "The municipality is competent to legislate on the environment with the Union and the state, within the limits of its local interest and provided that such regulation is in harmony with the discipline established by the other federal entities." Quoting Hely Lopes Meireles, the Court points out that the local interest is characterized by the predominance, and not by the exclusivity of the interest for the municipality, in relation to those of the state and

the Union, since there is no municipal matter that is not reflexively of state and national interest. The difference is only that of degree, not of substance.

Conceptualizing local interest, according to STF judge Luiz Fux, rapporteur for the appellate decision, is a simple task. However, the definition of the term will only be obtained through analysis of each concrete case.

The parameter for identifying local interest, according to the vote of STF judge Luís Roberto Barroso, must be assessed on a case-by-case basis, in an exercise of shifting the definition of jurisdiction in the abstract to a more concrete plan: the scope of interest.

In 2016, when judging the constitutionality of a law from the city of Palmitos in Santa Catarina that prohibited the commercialization and application of the herbicide 2.4-D in its territory, the Supreme Federal Court – Extraordinary Appeal 930407/2016 – conditioned the constitutionality of the municipal law to due demonstration of the local peculiarity motivating the ban, especially when federal and state legislation authorizes the circulation of the herbicide.

The same case had been judged by the Court of Justice of Santa Catarina (Argument of Unconstitutionality in Reexamination Necessary in Writ of Mandamus – Arguição de Inconstitucionalidade em Reexame Necessário em Mandado de Segurança 2004.018087-0/0001.00), which did not find evidence of unconstitutionality in the legislative activity of the municipality that – in strict attention to predominantly local environmental interests – proceeds to regulate, within its territorial limits, the use of the hormonal herbicide of the phenoxyacetic group (2.4-D), making use, for this purpose, of its supplementary constitutional jurisdiction granted by article 30, items I and II of FC/88.

Simply put, the predominantly local environmental interests, easily perceived in the decision of the Court of Justice of the state in which the city of Palmitos is located and which, therefore, has better conditions to "define", in the terms set by SFC judge Fux, its local interest or to "delimit" the scope of the municipality's interest, as it was "closer" to it, disappeared in the Supreme Court's decision, which was unable to identify the local peculiarities that gave rise to the prohibition. It is not enough, under the terms of the SFC decision, for Caesar's wife to be honest, she must be above suspicion.

It is not enough for the legislator to express by law – an intrinsically abstract act – the will of the people, it is necessary to indicate the reasons that gave rise to its substantiation, certainly present in the annals of its project!

The foundations of decisions involving concurrent jurisdictions in environmental matters are valid, keeping the due specificities, to delimit the legislative action of the states, the Federal District and

the municipalities, in the exercise of the prerogatives conferred by article 24 of the Federal Constitution, in matters pertaining to the right of innovation.

In this case, the Union establishes the general norms, while the states and the Federal District supplement them, adapting them to their peculiarities and, whenever local interest is present, the municipalities complement the federal and state legislation, complying with the following criteria: i) hierarchical superiority of federal legislation; ii) impossibility for state, district or municipal legislation to grant protection below the level determined by federal legislation to protected rights; iii) possibility of, observing items i and ii, states, Federal District and municipalities to innovate in terms of legislation regulating STI activities.

The contours of legislative "innovation" or the limits of the ability to innovate in the exercise of legislative supplementation and/or complementation find their guidelines in the constitutional provisions applicable to the STI and in the federal sectoral legislation.

Constitutional guidelines for science, technology and innovation activities in Brazil

Despite being topographically located in Title VIII of the 1988 Federal Constitution, intended to address issues related to the social order, such as social security, education, culture, sports, media, environment, family, children, teenagers, youth, the elderly and Indigenous peoples, in knowledge societies, there is a clear link between the science, technology and innovation sector and the constitutional dictates intended to govern the economy.

The Brazilian economic order finds its bases and guidelines in the 1988 constitutional text.

In Article 1 of the Federal Constitution of 1988, sovereignty, citizenship, human dignity, the social values of work and free initiative, and political pluralism are established as the foundations of the Federative Republic of Brazil, which, according to the will of the original legislator, etched in Article 3, should guide its action in achieving the following fundamental objectives: i) to build a free, fair and solidary society; ii) to ensure national development; iii) to eradicate poverty and marginalization and reduce social and regional inequalities; iv) to promote the good of all, without prejudice of origin, race, sex, color, age and any other forms of discrimination.

The foundations and principles chosen by the constituent power ensure the intentions deliberately expressed in the preamble of the Constitution, on the occasion of its formulation, namely: the institution of a

> [...] Democratic State, intended to ensure the exercise of social and individual rights, freedom, security, well-being, development, equality and justice as supreme values of a fraternal, pluralist and prejudice-free society, founded on social harmony and committed, in the internal and international order, to the peaceful solution of controversies [...].

Reading the beginning of the text, one can clearly see the option of those citizens, invested with the power to elaborate and promulgate a new constitution – a true milestone in the history of Brazil, which represents the exodus effected by the Brazilian people from a closed political system to a democratic one – for the consolidation of a State that guarantees rights of different dimensions, based on supreme values such as fraternity, plurality, social harmony and the solution of internal and external conflicts peacefully.

The economic order, according to article 170 of the Federal Constitution of 1988, must be based on the appreciation of human work and free initiative, aiming to ensure a dignified existence for everybody, according to the dictates of social justice, observing the following principles: national sovereignty (i); private property (ii); social function of property (iii); free competition (iv); consumer protection (v); environmental protection, including differentiated treatment according to the environmental impact of products and services and their preparation and accountability processes (vi); reduction of regional and social inequalities and pursuit of full employment (vii); favored treatment for small companies constituted under Brazilian law and which have their headquarters and administration in the country, also allowing the free exercise of any economic activity, regardless of authorization by public bodies, except in cases established by law (viii).

i) The indication of national sovereignty as the founding principle of the economic order means that political sovereignty and economic sovereignty go hand in hand. This principle can be interpreted from two angles, one related to the nation's international relations, and the other related to the autonomy of the individuals that compose it.

In the international sphere, the importance represented by economic strength as a determining factor of the interdependent sovereignty of any nation vis-à-vis other States is essential. Sovereignty, together with equality and solidarity, are also part of the fundamental principles of international development law, especially important to the so called Third World, as instruments for implementing the principles of non-intervention and non-aggression (FONSECA, 2004, p. 127).

Internally, national sovereignty is a result of the autonomy conquered by the people who compose the nation in all aspects, including economics.

ii) The principle of private property must be interpreted in conjunction with the contours that the Federal Constitution of 1988 gives it in

article 5, items XXII and XXIII, as well as in articles 182 and 186 of the same document.

In article 5, item XXII, the Constitution of the Federative Republic of Brazil lists property as a fundamental right, a right that is then specified by the dictates of item XXIII.

At this point, the current constitutional system breaks definitively with the old civil legislation, determining the proprietor's duty to revert to the benefit of the community the profits from *ius utendi*, *ius fruendi* and *ius abutendi*, classic powers, of a strictly liberal nature, inherent to the exercise of property, confirmed in article 1228 of the Civil Code.

In a systematic way, it is necessary to interpret the command of article 5, item XXIII, with the dictates of articles 182 and 186, all from the 1988 Constitution of the Federative Republic of Brazil, to define the outlines of urban and rural private property in the neo-constitutional era.

iii) Free competition is a means for achieving economic balance and is a corollary principle of free enterprise.

This, in turn, encompasses the right to enterprise – to create a company and manage it autonomously – which includes a) freedom of investment; b) the freedom of activity and organization of the company; c) freedom of negotiation or hiring; d) the freedom to compete. In its current conception, free enterprise should not be understood only as a private capacity of the individual, but as a right-function, a power-duty to be exercised in line with the social function (GOMES, 2004, p. 107-108).

iv) The protection of free competition stems from the understanding that free enterprise, in the sense of freedom of entrepreneurial initiative, presupposes not only the idea of freedom to access the market, but also the idea of freedom to remain in the market, i.e., free competition, understood as the freedom to exercise economic struggle without: (a) State interference; and (b) the obstacles imposed by other private economic agents (GOMES, 2004, p. 109).

v) Consumer protection finds shelter in articles 5, item XXXII, and 170, item V, both in the 1988 Constitution of the Federative Republic of Brazil, which, in article 48 of the Transitory Constitutional Provisions Act, determines the elaboration of a Consumer Protection Code by the National Congress.

This materialized through Law no. 8.078 of September 11, 1990, and it constitutes a microsystem for the protection of individual, homogeneous individual, collective and diffuse interests of consumers, considered as such in Article 2 of the aforementioned law, every natural or legal person who acquires or uses a product or service as final recipient.

Differentiated consumer protection, according to Grinover et al. (2018, p. 6), is the result of its vulnerability, which entails a contractual

imbalance with suppliers in a society marked by mass production and consumption and the absence of efficient market mechanisms to overcome or even mitigate this hypo-sufficiency.

vi) The constitutional outlines of the preservation of the environment are regulated in article 225 of the Federal Constitution of 1988 and are linked to a two-way process of judicialization of the environment and "greening" of the constitutional text, which Canotilho calls the "juridicization of ecology or ecologization of law".

vii) The principles of economic order, the reduction of regional and social inequalities and the pursuit of full employment are related to the founding objectives of the Federative Republic of Brazil to eradicate poverty and marginalization; reduce social and regional inequalities and guarantee a dignified life for all (article 3, III and article 1, III, both of the Federal Constitution of 1988).

The principle expresses the explicit recognition of marks that characterize the national context: poverty, marginalization and social and regional inequalities, an uncontested image of underdevelopment, which, however, is intended to be reversed. The Constitution, there, postulates nothing else, in its character of a governing Constitution, but the disruption of the process of underdevelopment in which we are immersed and, in which, poverty, marginalization and inequalities, social and regional, act in a regime of cumulative circular causation – are causes and effects in themselves.

The principles of articles 170, items VII and VIII, and 3, item III of the 1988 Constitution operate in the sense of updating Brazilian capitalism, overcoming the unevenness between its modern and archaic flanks.

viii) Article 179 of the 1988 Constitution of the Federative Republic of Brazil establishes the waiver of differentiated legal treatment for micro and small companies, aiming to encourage them, given the importance they have for the national economy and for job and income generation.

This regulation is in line with the general principle of economic activity of special treatment for small national companies, outlined in item IX of article 170 of the political charter.

Chapter IV of Title III of the 1988 Federal Constitution is dedicated to science, technology and innovation. It consists of two articles.

Article 218, as redacted by Constitutional Amendment no. 85/2015, is formed by the head paragraph (*caput*) and seven paragraphs.

Initially, the regulation entrusts the State to promote and/or encourage scientific development, research, scientific and technological training and innovation. Comparing the current text with the one in force before the enactment of Constitutional Amendment no. 85/2015, it appears that there was an increase in technological training and innovation among State duties in the STI sector, a fact that indicates

concern about the ability to transform science and technology into economic and social dividends.

The first paragraph is based on the premise that investment in the training of new scientists is essential to guarantee technological strength and ensures priority treatment by the State to basic scientific and technological research, aiming at the public good and the progress of science, technology and innovation. Paragraph 2, in turn, determines that technological research will predominantly focus on solving Brazilian problems and developing the national and regional productive system.

State support for the training of human resources in the areas of science, research, technology and innovation, including support for technological extension activities, occupies the third paragraph.

According to the Outreach, Culture and Student Affairs Council of the Federal University of Uberlândia (Universiade Federal de Uberlândia – UFU, 2020), technological outreach is the activity that, integrated with teaching and research, helps in the development, improvement and dissemination of scientific and technological solutions and in its availability to society and the market, and is governed by the following principles: i) integration between the university and public, private or state companies, in order to create an environment that stimulates joint innovation processes between these entities; ii) promotion of articulation between the university and the labor market; iii) constant opening of the institution's spaces to professional demands and contexts; iv) expansion of the function of the university's laboratories and teaching and research centers, in an extensionist perspective; v) incorporation of labor-market intrinsic situations in the generation of new knowledge; vi) promotion of technology transfer, respecting the legislation in force; vii) stimulation of technological development, including social technologies, practices and protocols for the production of goods and services; viii) creation and management of junior companies, enterprise incubators, technology parks and centers, cooperatives and solidary enterprises; ix) promotion of autonomy and emancipatory education through the development of processes and services; x) promotion of scientific and technological culture allied to social demands.

Following the Humboldtian model, technological extension connects universities to various economic and social actors, with the aim of creating interaction between the two agents and enabling a continuous dialogue that leads to the solution of technological problems, on the one hand, and to learning through experience on the other.

The fifth paragraph authorizes the states and the Federal District to bind a portion of their budgetary revenue to public entities for the promotion of education, and scientific and technological research.

The seventh paragraph deals with the internationalization of science, technology and innovation public institutions, aiming at scientific development, research, scientific and technological training and innovation.

Article 219 establishes the stimulus by the State to the formation and strengthening of innovation in companies, as well as in other public or private entities, and to the constitution and maintenance of parks and technological centers and other environments that promote innovation, the work of independent inventors and the creation, absorption, diffusion and technology transfer.

Amendment no. 85/2015 added Articles 219-A and 219-B to Chapter IV.

Article 219-A establishes that the Union, the states, the Federal District and the municipalities will be able to sign cooperation agreements with public bodies and entities and with private entities, including the sharing of specialized human resources and installed capacity, for the execution of research, scientific and technological development and innovation projects, through financial or non-financial consideration assumed by the beneficiary entity, as provided by law.

Article 219-B creates the National System of Science, Technology and Innovation (Sistema Nacional de Ciência, Tecnologia e Inovação – SNCTI), which will be organized in collaboration between public and private entities, aiming to promote scientific and technological development and innovation. The general norms of the SNCTI will be established by general law.

In addition to the constitutional provisions, the STI receives legal treatment in the Brazilian legal system.

Aspects of Brazilian federal legislation on science, technology and innovation

Much is said about the challenges that countries face in raising the level of economic development and well-being in society. If, at first, the greatest importance was given to investments in infrastructure, at the current stage of development, such a scenario no longer proves to be enough, since science, technology and innovation take on a first-rate place for boosting competitiveness and the economy.

At the national level, it is no different. According to Arbix (2020, p. 57-60), Brazil has historically invested in policies that encourage industrialization and economic competitiveness. However, it was believed that an agile economic growth would be able to naturally stimulate innovation and technology. Therefore, "[...] the development strategies adopted until the end of the 1990s did not established treatment or a special place for STI, among the instruments for leveraging economic development."

It was only after the year 2000 that the State became more engaged in the economy and in the market. However, the economic crisis and the flawed steering of public policies did not allow the changes to be enough to unlock the cycle of technological expansion (ARBIX, 2020, p. 57-60).

In addition, there were impacts due to the

> [...] low level of competition between sectors of great technological complexity, the high cost of opportunity of innovation, bureaucratic business environment and scarcity of resources destined to science, technology and innovation (ST&I). (BARBOSA et al., 2021, p. 26).

This scenario underwent notable transformations from 2004 onwards, when efforts turned to structuring an innovation system, articulating programs, enacting laws and creating new institutions (ARBIX, 2000, p. 57-60). The debates for the creation of adequate legislation for the STI operationalization were intensified since 2004, converging on the publication of laws and decrees, among which: a) Law no. 10.973/2004, recognized as the "Innovation Law", which aims to create measures that encourage innovation and scientific research; b) Decree no. 5.563/2005, which regulates Law no. 10.973/2007; c) Law no. 11.196/2005, referred to as the "Lei do Bem" (the Law of good), which establishes mechanisms of tax reliefs for investments in innovation projects; d) Decree no. 7.798/2006, which regulates tax incentives for innovation established in Law no. 11.196/2005; e) Law no. 11.487/2007, which amends Law no. 11.196/2005.

On February 26, 2015, with the enactment of Constitutional Amendment no. 85 and Law no. 13.243/2016, on January 11, 2016, the legal treatment given to science, technology and innovation in Brazil through new provisions was updated. Since then, Brazilian legislation has the so-called "Marco da Inovação no Brasil" (Brazilian Innovation Milestone).

Segundo (2019, p. 66) reports some of the main facts involving the mobilization for the new innovation framework:

> [...] the creation of more adequate legislation, both for fundamental research and technological development and its contribution to innovation, has become one of the main concerns of the academic representative entities, which resulted in a series of requests from entities such as the Academy of Sciences (Academia de Ciências – ABC) and the Brazilian Society for the Progress of Science (Sociedade Brasileira para o Progresso da Ciência – SBPC) for measures from the executive branch, demanding not only that such solutions be implemented, but assuming a more proactive role, elaborating draft instruments to support government actions.

In 2010, during the 4th National STI Conference, in Brasília, the need for new legislation was discussed. "At the end of the event, President Lula committed to work on a proposal to revise the legislation coming

from the scientific community that could be approved by Congress." (SEGUNDO, 2019, p. 67).

Subsequently, the National Council of Research Support Foundations and the National Council of State Secretaries for Science, Technology and Innovation Issues (Conselho Nacional das Fundações de Amparo à Pesquisa and Conselho Nacional de Secretários Estaduais para Assuntos de Ciência, Tecnologia e Inovação) presented proposals for law changes, leading to Bill no. 2.177/2011, which started to follow legal channels in the House of Representatives, known as the National STI Code (Código Nacional de CTI), and Senate Bill n. 619/2011.

The elaboration of the advisory opinion for Bill 2.177/2011 had the broad involvement of academia, industry, ministries, institutions, development agencies, universities, the command of the armed forces, among others. And, after intense debates in meetings, public hearings and seminars, Constitutional Amendment Proposal no. 290/2013 was signed by Deputy Margarida Salomão and by Deputy-rapporteur Izalci Lucas (SEGUNDO, 2019, p. 67-68).

The text of Constitutional Amendment Proposal no. 290/2013 justifies the changes mainly stating that: i) the update comes from manifests from entities that work in the area of STI; ii) Brazil needs to consider more adequate technological solutions to face the economic challenges in the productive sector; iii) it is necessary to reinforce the State's participation in actions to stimulate technology and innovation excellence; iv) there is a need for harmonization between actions at the federal, state and municipal levels, requiring concurrent jurisdiction to formulate norms; v) for the STI system to have greater effectiveness, the procedures should be less bureaucratic; vi) openness to sharing research infrastructure and know-how of the parties in cooperation projects is valid and may be detailed by law; vii) the creation of a National STI System would coordinate the actions of public and private entities, fostering collaboration. Furthermore, it stresses that:

> Such amendments to the Charter will create opportunities to integrate technological research institutions and innovative companies into a national system, reaching the federal, state and municipal spheres, as a way of allying efforts to finance and coordinate technological development and technological extension activities. (BRASIL, 2013).

The unanimous approval resulted in Constitutional Amendment no. 85, which amended and added provisions to the Federal Constitution, aiming to update the treatment of STI activities, allow greater integration between research institutions and technology companies, align efforts for economic development and promote support from federal, state and municipal governments.

Azin (2020) states that it is possible to separate Constitutional Amendment no. 85/2015 into four main axes: i) Science, Technology and Innovation Policy becomes a State policy; ii) adoption of the term

innovation together with Science and Technology, demonstrating the need for integration with the private sector; iii) adoption of the triple helix theory; iv) de-concentration and decentralization of powers to regulate the STI system.

Following Barbosa et al. (2021, p. 35), the Constitutional Amendment no. 85/2015:

> a) altered the material and concurrent legislating powers of political entities on science, technology, research, development and innovation; b) streamlined the possibility of transposition, relocation or resource transference from a programming category, within the scope of science, technology and innovation activities; c) determined that the government will grant financial support to research, extension and stimulus and innovation promotion activities carried out not only by universities, but also by professional and technological education institutions; d) reinforced the role of government in encouraging scientific development, research, scientific and technological training, and innovation, including innovative companies and technology centers; e) establishes instruments of cooperation with public bodies and entities and with private entities, including the sharing of specialized human resources and installed infrastructure capacity, for the execution of research, scientific and technological development and innovation projects; and f) determined the creation, by federal law, of the National System of Science, Technology and Innovation that will establish the guidelines for public policy on STI.

As the "[...] stage of Constitutional Amendment-85, published in February 2015, was overcome, the discussion of Bill 2177/2011 was resumed, which could not really be constituted as a Code [...]", since this would give it a certain rigidity and hinder the expected periodic updates and optimizations (SEGUNDO, 2019, p. 70).

Thus, efforts were concentrated on reaching the consensual text of Complementary Bill 77/2015, which was presented to the Senate, on December 18, 2015, by the Senator-rapporteur Jorge Viana. Then, Law no. 13.243, of January 11, 2016, was sanctioned and called the New Legal Framework for STI. Even so, some devices needed to be changed, resulting in Provisional Measure 718/2016 and, subsequently, in Law no. 13.322/2016. Decree no. 9.283, of February 7, 2018, was published in order to regulate the STI Legal Framework.

Among the considerations presented during the processing of Complementary Bill 77/2015, Advisory Opinion no. 1078 that: "The amendments aim to simplify and make scientific development, research, scientific and technological training and innovation in the country more dynamic." (BRASIL, 2015, p. 2). And he adds that the amendments would establish principles to strengthen the relationship between the different institutions, promoting:

> (i) the promotion of cooperation and interaction between public entities, the public and private sectors and between companies; (ii) stimulus to innovation activity in Scientific, Technological and Innovation Institutions (STIs); (iii) promotion of business competitiveness in national and international markets; (iv) simplification of procedures

> for the management of science, technology and innovation projects and the adoption of control by results in their evaluation; and (v) use of the State's purchasing power to encourage innovation.

The opinion elucidates that the generation of knowledge and the ability to transform it into innovation are fundamental for the development of the country. And concludes that

> [...] the amendments proposed by Complementary Bill no. 77 of 2015 will contribute to bringing academia and the productive sector together in a less bureaucratic way, providing greater legal security for STIs, companies and researchers to be able to dedicate themselves to joint innovative projects. (BRASIL, 2015, p. 9).

Vale (2018, p. 148-149) reinforces that the legislator's intention was to highlight the importance of scientific and technological development, scientific training, research and innovation. However, he states that although it is a great advance, it is not possible to just settle on the legislative change, because without "[...] concrete practices to implement the Federal Constitution and the Innovation Law, it will be one more norm to be solemnly ignored."

Law no. 13.243 of January 11, 2016 promoted partial changes in several laws that: i) define the legal status of foreigners in Brazil; establish norms for Public Administration biddings and contracts; iii) define the Differentiated Regime for Public Contracting (Regime Diferenciado de Contratações Públicas – RDC); iv) establish hiring for a fixed period to meet the temporary need of exceptional public interest; v) deal with the relations between the federal institutions of higher education and scientific and technological research and the support foundations; vi) establish criteria for imports of goods intended for scientific and technological research; vii) exempt or reduce import taxes; viii) structure the Career and Position Plan for Federal Teachers (Plano de Carreiras e Cargos do Magistério Federal).

In addition, Law no. 13.243/2016 had a significant impact on Law no. 10.974/04, which establishes measures to encourage innovation and scientific and technological research in the productive environment. Thus, the legal framework for science and technology in Brazil is constituted by Law no. 10.974/04, with amendments to Law no. 13.243/16.

According to the sole paragraph of article one of Law no. 10.973/2004, with amendments to Law no. 13.243/2016, the measures to encourage innovation and scientific and technological research in the productive environment must observe, among others, the following principles: i) promotion of scientific and technological activities as strategic for economic and social development; ii) promotion and continuity of scientific, technological and innovation development processes, ensuring human, economic and financial resources for this purpose; iii) reduction of regional inequalities; iv) decentralization of science, technology and innovation activities in each sphere of government,

with de-concentration in each federal entity; v) promotion of cooperation and interaction among public entities, between the public and private sectors and among companies; vi) incentive to innovation activity in Scientific, Technological and Innovation Institutions (STIs) and in companies, including atrtracting, constituting and installating research, development and innovation centers and technology parks and centers in the country; vii) promotion of business competitiveness in national and international markets; viii) encouraging the creation of favorable environments for innovation and technology transfer activities; ix) promotion and continuity of education and scientific and technological training processes; x) strengthening of operational, scientific, technological and administrative capacities of STIs; xi) attractiveness of the development and credit instruments, as well as their constant updating and improvement; xii) simplification of procedures for managing science, technology and innovation projects and adoption of control by results in their evaluation; xiii) use of the State's purchasing power to encourage innovation; xiv) support, encouragement and integration of independent inventors in STI activities and in the production system.

Three principles are especially relevant: the one that deals with the promotion of scientific and technological activities as strategic for economic and social development; requiring the reduction of regional inequalities; and determining decentralization and de-concentration of science, technology and innovation activities in each sphere of government and each federal entity.

The relevance of these principles is due to their potential to qualify the environmental variable.

In Principle I, which advocates the promotion of research and technology activities as strategies for economic and social development, the simple replacement of the expression "economic and social development" by the term "sustainable development", would already indicate that the framework of science and technology would be committed to research aimed at promoting economic development, distribution of wealth and ensuring the quality of the environment.

The same reasoning applies to principle 3. It is not enough for the advancement of science to reduce regional inequalities; it is necessary to declare that the socio-environmental problems of the poorest regions are solved.

The decentralization and de-concentration of science, technology and innovation activities in each sphere of government and in each federal entity is a very welcome principle, since, if put into practice, it will reduce the centrality of the Ministry of Science and Technology (Ministério da Ciência e Tecnologia) in the sphere of public policies for science, technology and innovation, at the federal level, and will

allow state foundations to promote scientific research to have greater autonomy when defining what type of research will be funded, which, in theory, will enable the allocation of greater contributions on impact science-based research, given the diversity of socio-environmental problems in Brazil.

The changes proposed in this text to the three principles could be carried out by state, district and municipal legislation that may supplement or complement federal legislation.

Article 27 of Law no. 10.973/2004, with amendments to Law no. 13.243/2016, addresses the guidelines for the science and technology framework application.

According to items I, II, IV and VI of that article, the agents involved in the R&D processes must: i) prioritize, in the less developed regions of the country and in the Amazon, actions aimed at providing research and the regional production system with more human resources and technological training; ii) support programs and projects to encourage innovation in the national defense industry and to expand the exploration and development of the Exclusive Economic Zone (EEZ) and the continental shelf; iv) give preferential, differentiated and favored treatment in the acquisition of goods and services by public authorities and support foundations for the execution of institutional development projects to companies investing in research and technology development in the country and to micro-enterprises and technology-based small businesses, created in the context of STI research activities; vi) promote the development and dissemination of social technologies and the strengthening of technological outreach for productive and social inclusion.

From the analysis of this article, it is inferred that the application of the law follows guidelines privileging research aimed at development of economic exploration in specific areas. There is no guideline concerned with environmental and social issues, which can be corrected at the state and/or municipal level.

The exception is found in item VI, which determines the promotion of the development and dissemination of social technologies. It is a known fact that social technologies, in addition to including economically excluded people, have the potential to bring great benefits to the environment.

Initiatives such as social technology incubators are examples of the benefits that investments in social technology can bring to improve people's quality of life and to preserve the environment as a whole, which is one of the basic premises of science that contributes to the promotion of sustainable development.

The legal framework for science and technology encourages, in Article 19, innovation in Brazilian companies and Brazilian non-profit entities through the concession of financial, human, material or infrastructure

resources to be adjusted in specific instruments and destined to support activities of research, development and innovation to meet the priorities of national industrial and technological policies.

Despite the first article paragraph referring to the establishment of priorities for national industrial and technological policy and regulation, one can see the clear connection of such policies to economic interests alone. Socio-environmental issues are clearly relegated to a secondary position. Again, the hands of state and local legislature could correct this distortion.

Finally, Law no. 10.973/04, amended by Law no. 13.243/2016, deals with encouraging independent inventors.

According to item IX of article 2 of Law no. 10.973/04, an independent inventor is an individual, not holding an effective position, military position or public employment, who is a creation's inventor, obtainer or author.

Article 22 determines that an independent inventor, who proves the filing of a patent application, may request the adoption of his creation by a public Scientific, Technological and Innovation Institution (STI), which will decide on the convenience and opportunity of the request and the preparation of a project aimed at evaluating the creation for future development, incubation, use, industrialization and insertion in the market.

In this case, the Union, the states, the Federal District, the municipalities, the development agencies and the public Scientific, Technological and Innovation institutions will be able to support the independent inventor who proves the registration of a patent for his creation, among other ways, through: i) analysis of the technical and economic viability of the object of invention; ii) assistance in transforming the invention into a product or process with the financial and credit mechanisms provided by law; iii) creation assistance for a company that produces the object of the invention; iv) guidance for transferring technology to established companies.

Despite seeming peripheral, the innovation incorporated by Law no. 13.243/2016 to article 22 of Law no. 10.973/04 is one of the propositions of the legal framework for science and technology with great potential to generate sustainable economic, social and environmental development, since it enables the independent inventor to receive technical and economic support from public STIs for the insertion of his invention in the market.

With this, new horizons are opened for the "science-citizen" who dedicate themselves to research based on the solution of social and environmental problems in their surroundings.

The treatment given to the independent inventor by the federal legislation can be improved by the states, Federal District and municipalities guaranteeing benefits to public, community or

private STIs that are willing to incubate, use, industrialize or insert such inventions in the market and, with that, guarantee a true democratization of innovation.

Conclusion: proposals to improve the science, technology and innovation legislation of Santa Catarina and its municipalities based on the national sectoral legislation

Santa Catarina has specific legislation to deal with STI. In addition to its Constitution, it has Law no. 14.328/2008, amended by Law no. 16.382/14, which establishes measures to encourage scientific and technological research and innovation, and its Regulatory Decree no. 2.372/2009.

In order to adjust said legislation to Constitutional Amendment no. 85/2015, the Constitutional Amendment Bill no. 001.0/2021, whereby innovation is now treated as an essential topic for economic development, and in which the state must provide and encourage the means of access to technology and innovation (SANTA CATARINA, 2021), is currently going through the legal channels in the State Legislature.

With the changes promoted by Constitutional Amendment no. 85/2015 in Articles 23 and 24 of the Federal Constitution of 1988, the State assumes, together with municipalities, the Federal District and the Union, the leading role in promoting STI actions and policies, and must adapt the legislation to its peculiarities.

For Farranha (2019, p. 174), the set of changes that Constitutional Amendment no. 85/2015 has brought also enabled greater articulation in STI between the State, the market and society.

Such articulation is possible, for example, by the legal instruments of STI specific partnerships included by Decree no. 9.283/2018: i) Grant Term: instrument for granting scholarships, grants, technological bonuses and economic subsidy. This modality depends on the normative act of the body or entity, in order to adapt values, deadlines and responsibilities; ii) Partnership agreement for RD&I: the instrument signed by Science and Technology Institutes (STI) with public and private institutions for joint actions and activities for research, scientific and technological development. In this modality, the partners work together without transferring public resources; iii) Agreement for RD&I: voluntary transfer instrument between federal bodies and entities, development agencies and public and private STIs for the execution of research and innovation development projects, relying on public financial resources (CAMPAGNOLO; VELHO, 2019, p. 143).

It so happens that, in parallel with the interest in ensuring the growth of the economy, there is a concern about democratic, sustainable and responsible technological innovations. This is a challenging scenario

for STI policies, since actions must prioritize not only the volume of investments, but those that impact the target object, especially projects aimed at the social challenges of Santa Catarina and its municipalities, in the present analysis.

Aiming at contributing to the improvement of Santa Catarina and municipal legislations dedicated to the subject, some proposals for improvement, that were in some way the subject of chapters in this the book, are indicated.

Some proposals are scattered throughout the preceding texts, such as those indicated in the item "Aspects of Brazilian federal legislation on science, technology and innovation" in this chapter. However, there are "innovative" experiences, in terms of innovation governance, which could very well be incorporated into the governing legislation of the state and municipalities.

Incorporating Responsible Research and Innovation (RRI) and Safe by Design-based research practices

For Vale (2018, p. 148-149), although Brazilian legislation has advanced, without the implementation of concrete practices it will become nothing more thana neglected norm. The author states that one should promote:

> [...] a propitious and suitable place for the flourishing of an educated, well-trained and informed, enterprising, ingenious and capable youth. Technological autonomy stems from the training and self-sustainability of the technological system. Science, Research and Development go hand in hand and technology is still a reflection of investments in various sectors directly or indirectly involved and reciprocally intertwined with each other, making it difficult, perhaps impossible, to separate them.

From this perspective, since 1983 the European Union has adopted the idea of a community research and development policy called the Framework Program.

In order to structure and implement the policy, the political bloc created actions for research programs in the field of science and technology aiming at joining efforts, defining priorities and meeting the common needs of society.

For the 2021 to 2027 period, the 9th Framework Program, "Horizon Europe", dedicates its investments, as a priority, to activities that contribute to the Sustainable Development Goals (EUROPEAN COMMISSION, 2020).

RRI emerged from European discourses on the importance of research process and responsible innovation for creating an environment of economic growth in line with society's values and expectations (REILLON, 2017).

It was formally initiated when it was included as a cross-cutting issue in the transition from the seventh Framework Program to the eighth Framework Program (OWEN; PANSERA, 2019), however, its greatest propulsion took place within Horizon 2020, the period in which its principles and tools were developed for implementing and disseminating knowledge and good practices.

RRI is adopted by the European Commission as being:

> Responsible research and innovation is an approach that anticipates and assesses potential implications and societal expectations with regard to research and innovation, with the aim of fostering the design of inclusive and sustainable research and innovation. RRI implies that societal actors (researchers, citizens, policy makers, business, third sector organisations, etc.) work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society. (EUROPEAN COMMISSION, 2020).

To qualify as an RRI, the research and innovation process needs to include four main dimensions.

The first is aimed at the inclusion of different knowledges, collected from all those involved, influenced by research and innovation, from the beginning to its implementation.

The second relates to the openness and transparency of information at all stages of the process, facilitating discussions and providing well-informed decisions.

The third deals with anticipating and reflecting on immediate and future impacts, considering the desirable future and responsibility for actions.

Finally, there is the adaptive response of research and innovation according to stakeholder opinions (RRI TOOLS, 2016, p. 8-12).

With the support of the European Commission in Horizon 2020, a normative framework is established with six key elements that the practice of RRI must promote: research ethics and integrity; gender equality; governance; open access; public engagement; and science education.

Examples of projects based on the RRI concept are:

I) TechTransformed: a tool that helps in the strategy, development and design of products, focusing on the main challenges that companies face in being farseeing, reflective and responsible with new technologies. Resources allow companies to innovate with different mindsets; grow responsibly; attract and retain talent; and develop better products (RRI TOOLS, 2020c).

II) MARINA: seeks to create a synergy between the research and innovation environment and environmental protection. The project tackles eight fronts: marine biotechnology; maritime transport, offshore mining; climate changes; renewable energy (from waves and winds); the tourism of coastal cities; fishery and aquaculture; man-made pollution. To achieve this, it envisages

carrying out workshops, platforms for knowledge sharing, policy mobilization to institutionalize RRI principles, creation of guides and good practices for RRI and seminars (RRI TOOLS, 2020b).

III) KlimaAlltag: Field research is carried out to investigate "low carbon lifestyles" in different social situations, focusing on mobility, nutrition, lifestyle, and energy consumption of families. Its main objectives are:

IV) to develop target-group specific strategies to promote low-carbon lifestyles; ii) determine starting points, options and limits concerning the decarbonisation of everyday routines; and iii) evaluate climate-related measures supporting climate-friendly everyday routines. (RRI TOOLS, 2020a).

Hohendorff (2018, p. 313) argues that RRI is one of the greatest contributions of the European Commission for the promotion of sustainable and responsible innovation, especially for "[...] building a better relationship between science and society, with promoting a link between science and technology and a socially desirable environment."

The complexity of the research and technology innovation process inevitably expands in society. Although recent, the RRI, with its history, organization, characteristic, and application, is configured as an important tool to promote sustainable, democratic and inclusive STI.

The adaptation and application of the RRI in the innovation policy of Santa Catarina can bring, in essence, a new culture of socio-environmental protection, i.e., a change in behavior.

RRI, when actually implemented, can be considered highly acceptable by society, since it is from its approach that all interested parties obtain the capacity to act directly, to share their knowledge and to make results transparent. It guarantees, therefore, greater democracy in decision-making in the management of the technological innovation process, as well as evokes shared responsibility.

Safe by Design, duly presented in the previous chapter by Raquel von Hohendorff, is a strategic tool to ensure the introduction in society and in nature of new products designed not to cause damage either to consumers or the elements of the environment.

The adoption of mechanisms based on the manufacture of harmless substances to a healthy quality of life could be a general guideline of the STI legislation in Santa Catarina, which would guarantee the protection of human rights and the environment without incurring in unconstitutionality, since the systematic interpretation of the applicable constitutional provisions guarantees that states and municipalities establish more effective levels of protection than those provided for in federal legislation.

Encouraging municipalities to create STI policies that favor the specificities, environmental limits, economic and social needs, characteristics and vocation of the place where they will be implemented

As Constitutional Amendment no. 85/2015 modified article 23 and 24 of FC/88, STI becomes one of the matters assigned to the common (article 23) and concurrent (article 24) jurisdiction regimes.

Thus, the Union, states, Federal District and Municipalities assume the role of protagonists in promoting STI actions and policies and hold concurrent jurisdiction to legislate on the subject, adapting the legislation to their peculiarities.

This factor makes it desirable for bodies responsible for STI to work with the municipalities at the state level, in order to adapt municipal legislation and promote an endogenous innovation environment that is more suited to local problems, since it is in the municipalities that people live together and organize themselves.

To this end, state STI legislation could establish principles, actors and instruments based on the following criteria:

i) respect for municipal autonomy;
ii) creation and strengthening of innovation networks with the parCTIipation of municipalities;
iii) creation and strengthening of innovation networks among municipalities;
iv) encouraging the participation of the population in STI activities;
v) consideration of the municipalities' aptitude to induce regional innovation policies;
vi) economic diversification of municipalities by inducing innovation and entrepreneurship in multiple economic activities with low socio-environmental impact or that, preferably, improve or mitigate existing environmental impacts;
vii) induction of social innovation in STI policies.

Using legal instruments provided for in federal STI legislation

In the chapter "Legal security and incentives for innovation environments: an analysis based on the legal framework of science, technology and innovation", Cristiani Fontanela and Andréa de Almeida Leite Marocco analyze three instruments to encourage technology transfer, established in Decree no. 9.283/2018, which regulated the new Brazilian legal framework for STI and which can be incorporated into Santa Catarina and municipal legislation.

Encouraging the development of cooperative projects involving companies, STIs and non-profit private entities, the Centers for Technology Innovation (CTI) that may be constituted with their own

legal personality, and the facilitation and reduction of bureaucracy in the transfer of public STI technology to the private sector constitute important incentive instruments for the creation of safe and favorable environments for innovation.

If established by law, these and other similar instruments would enjoy greater legal certainty, which would represent obvious gains for business involving STI.

Using legal instruments provided for in sectoral legislation that improve the governance of the STI area: regulated self-regulation and the sandbox

In democraic rule-of-law States, the adequate political ambience for the diversification of industrial sectors depends, in a significant way, on a legal scenario that confers legal security – in the most diverse aspects – to institutions dedicated to science, technology, innovation and distribution of knowledge.

In other words, a country's capacity for innovation depends significantly on institutional conjunctures of science, technology and innovation and on governance scenarios that bring security to various actors that act in processes linked to, as Klaus Schwab (2019) calls it, the Fourth Industrial Revolution.

Governance structures can be architected in a variety of ways. They range from purely governmental arrangements to legal institutes, codes of conduct, normative standards, technical standards, among others, based on self-regulation.

Between hetero-regulation – understood as the establishment and verification of rules made by a third party, frequently the State – and self-regulation – based on rules constructed by those who will be affected by the normative standard, the stakeholders – there is regulated self-regulation.

According to Hohendorff (2018, p. 372), regulated self-regulation, or co-regulation, is a "[...] hybrid form of regulation, which combines political-state regulations with private collective agreements [...]" and takes advantage of pluralistic regulatory strategies that involve a network of State and non-state actors in the design and application of norms.

In architectures of regulated self-regulation, the State does not relinquish its regulatory power and acts as a kind of regulatory coordinator (HOHENDORFF, 2018, p. 379).

From a theoretical point of view, Franzius (2018) argues that self-regulation is justified by the convergence of three lines of reasoning:

i) the State guarantees and recognizes regulated self-regulation as a mode of action: the State will be responsible for structuring a meta-regulation, guaranteeing the constitutionally accepted qualitative elements of self-regulation proposals;

ii) the institution of networks for the description of certain phenomena: the structuring of networks that interconnect the various actors involved, in which the consumer must be heard especially about the level of risk that he is willing to take in the name of techno-scientific innovation. Organizations should, in order to structure the organization that complies with the Law, place the consumer in their production cycle of new products;

iii) the governance perspective on the regulatory structure: internal actions will be necessary, but with external reflections, in organizations.

Regulated self-regulation is justified by the observation of the difficulties of traditional state regulation in the face of the risks of new technologies and innovation, as it adds, to the governance strategies of environmental and technological risks, better communication among civil society, the State, organizations and scientists (COGLIANESE; MENDELSON, 2010).

Through it, the "[...] State does not delegate all regulation to the private sector, nor does it have all the control, but develops strategies for supervising private self-regulation mechanisms." (HOHENDORFF, 2018, p. 372).

Forms of regulated self-regulation arise, according to Franzius (2018), from a practical need: the lack of knowledge about the social, environmental and economic risks of new technologies, inventions and innovations become part of experimental legislation and are adapted to conditions of success. It functions as a kind of test of formal regulation (HOHENDORFF, 2018, p. 380).

One of the most used self-regulation mechanisms today is the regulatory sandbox.

Coutinho Filho (2018, p. 268-269) defines this as a regulatory instrument through which the regulator grants a temporary authorization for certain companies to provide services or offer financial products with a regulatory discount in relation to current regulations, provided that their activities are within the limits pre-established by the regulator.

The sandbox surpassed the barriers of the financial field and became of interest and use in the technological sectors. Mello (2021) states that the sandbox is:

> [...] an experimental space, isolated and safe, capable of functioning as a testbed for new solutions. This environment works with a more flexible regulatory framework for innovative companies to perform for a limited number of users, for a limited time. From this, verifying problems or possible risks of these new products is possible and, if all goes well, the product will be released to the market, following the timing of major disruptive changes.

In Brazil, sandboxes have already been used by the Central Bank to establish operating guidelines for testing financial innovations and payments, by the Superintendence of Private Insurance (Superintendência de Seguros Privados – Susep) to create a more transparent regulatory environment, and by the Securities and Exchange Commission (Comissão de Valores Mobiliários – CVM) to produce academic studies on regulatory aspects and the interaction between traditional banks and fintechs (MELLO, 2021).

Although in most countries the sandbox has been instituted by the law of regulation, through ordinances, normative instructions and other instruments issued by regulatory agencies, in Brazil, the mechanism was established by Complementary Law no. 182 of June 1, 2021, which defined the Regulatory Framework for Startups and innovative entrepreneurship – which already denotes the extrapolation of the mechanism to other areas beyond finance.

Article 2, item II of Complementary Law no. 182/2021 defines experimental regulatory environment (regulatory sandbox) as the set of simplified special conditions so the participating legal entities can receive temporary authorization from bodies or entities with sectoral regulation jurisdiction to develop innovative business models and test experimental techniques and technologies, upon compliance with criteria and limits previously established by the regulatory body or entity and through a facilitated procedure.

Article 11 of Complementary Law no. 182/2021 determines that public administration bodies and entities with sectoral regulatory jurisdiction may, individually or in collaboration, within the scope of experimental regulatory environment programs (regulatory sandbox), remove the incidence of rules under its jurisdiction in relation to the regulated entity or groups of regulated entities.

As can be seen, the intention of the law is to create specific regulatory environments, free from the incidence of regulatory norms, aiming at creating business models and testing, within parameters defined by regulatory agencies, new technologies.

The way the sandbox is dealt with by the regulatory framework of startups deserves close attention from those responsible for drafting STI legislation in Santa Catarina and municipalities.

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