# ANALYSIS OF THE INTERACTIONS BETWEEN THE NATIONAL SERVICE FOR INDUSTRIAL TRAINING INNOVATION INSTITUTES AND COMPANIES OF SANTA CATARINA FOR INNOVATIVE DEVELOPMENT*

## ANÁLISE DAS INTERAÇÕES DOS INSTITUTOS DE INOVAÇÃO DO SERVIÇO NACIONAL DE APRENDIZAGEM INDUSTRIAL E AS EMPRESAS DE SANTA CATARINA PARA DESENVOLVIMENTO INOVATIVO

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**Abstract:** This study aims to analyze the interaction of research institutes and companies in their institutional and innovative aspects, from the study on the National Service for Industrial Training (SENAI) Innovation Institutes in Santa Catarina and companies. The neo-Schumpeterian perspective and its analytical framework of the innovation system and processes of knowledge generation, learning, and routines were adopted as theoretical basis. This is a descriptive research with a qualitative approach, developed from data obtained through an integrative, documentary research and carrying out a case study. The data sample consisted of industrial companies in Santa Catarina that completed innovation projects throughout 2017 and the first half of 2018 with more than 100 hours of services provided by the SENAI Innovation Institutes. The main conclusions of this research fall on the sharing of knowledge transferred from the institutes to the companies through meetings, technical reports, videos, and documents; occurrence of different forms de learning, as well as routine procedures, changes in processes, and development of physical systems in the projects carried out. Innovations resulting from the established institutional interactions appear as incremental.

**Keywords:** SENAI Innovation Institutes; Research institute and companies interactions; Innovative system.

**Resumo:** O objetivo deste trabalho é analisar a interação dos institutos de pesquisa e empresa nos seus aspectos institucionais e inovativos, a partir dos estudos sobre os Institutos do Serviço Nacional de Aprendizagem Industrial (SENAI) de Inovação de Santa Catarina e as empresas catarinenses. Adotou-se como base teórica a perspectiva neoschumpeteriana e seu referencial analítico de sistema de inovação e dos processos de geração do conhecimento, aprendizado e rotinas. Trata-se de uma pesquisa descritiva de abordagem qualitativa. Os dados foram obtidos por meio de uma pesquisa integrativa, documental e realizado um estudo de caso. A amostra dos dados foi constituída pelas empresas industriais de Santa Catarina que concluíram projetos de inovação no período de 2017 e primeiro semestre de 2018, com mais de 100 horas de serviços prestados pelos Institutos SENAI de Inovação. A pesquisa foi aplicada em três empresas selecionadas e em três representantes do SENAI. As principais conclusões desta pesquisa recaem sobre o compartilhamento do conhecimento repassado dos institutos para as empresas por meio de reuniões, relatório técnico, vídeos e documentos; ocorrência de diferentes mecanismos de aprendizagem; bem como, de procedimentos de rotinas, mudanças em processos e desenvolvimento de sistemas físicos nos projetos realizados. As inovações decorrentes das interações institucionais firmadas figuram como incrementais.

**Palavras-chave:** Institutos SENAI de Inovação; Empresas catarinenses; Sistema inovativo; Teoria neoschumpeteriana.

**Classificação JEL:** O3; O30; O32

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## 1 Introduction

The innovation theme has been on the economic growth agenda since 1911, with the publication of Schumpeter's Theory of Economic Development, in which the author considered innovation as the main reason for the great leaps in economic growth in the human race evolution (TIGRE, 2005). For Schumpeter (1997), innovation consists of the combination of materials and forces that are within our reach, it would be something like producing other things, or the same things, but with different methods.

Contributing to the understanding of innovation promoting development, neo-Schumpeterian authors – Freeman, Lundvall, Edquist, and Nelson – have developed the concept of the National Innovation System (NIS). In particular, Freeman (1995) defined NIS as a set of institutions, actors, and mechanisms – in a country – that contribute to the creation, advancement, and dissemination of technological innovations. The main actors and mechanisms in this system include research institutes, the educational system, firms and their research and development laboratories, government agencies, the financial system structure, intellectual property laws, and universities.

In Brazil, efforts have been made to create an innovation system that contributes to the country's development. Within this context, the National System of Science, Technology, and Innovation (SNCTI) appears, aiming to encourage the development of innovations and the generation of knowledge with companies. The National Service for Industrial Training (SENAI) and the National Industry Confederation (CNI) are part of this system. Such actors have developed a plan for the creation of the SENAI Innovation Institutes (ISIs) and the SENAI Technology Institutes (ISTs).

The SENAI Innovation Institutes (ISIs) have a nationwide scope, and are focused on providing research services, and development of product and process innovations. Some ISIs, in just a few years of operation, have already been accredited as units of the Empresa Brasileira de Pesquisa e Inovação Industrial (EMBRAPII): ISI in Biomass-MS, ISI in Electrochemistry-PR, ISI in Metallurgy and Special Alloys-MG, ISI in Sensing-RS, CIMATEC-BA, ISI in Embedded Systems-SC, and ISI in Manufacturing Systems-SC.

As a contribution to this process of implementing a new innovative scenario for Brazil, the SENAI of Santa Catarina made large financial investments for the opening of Research Institutes, with the implantation sites planned according to the concentration of the industrial sectors in the state. The SENAI Institutes of Innovation and Technology were distributed as follows: Joinville (ISI in Manufacturing Systems and ISI in Laser Processing); Florianópolis (ISI in Embedded Systems and IST in Automation and ICT); Chapecó (IST in Food and Beverage); Blumenau (IST in Textile, Clothing, and Design and IST in Environment); Criciúma (IST in Materials); Jaraguá do Sul (IST in Electro-electronics); and Itajaí (IST in Logistics).

ISI in Manufacturing and Laser Processing Systems and ISI in Embedded Systems are reference institutes. The first is located in Joinville, where industrial companies are concentrated, with a strong concentration in the metalworking sector. From 2013 to 2017, these ISIs provided more than 94,000 hours of service in research, development, and innovation projects, serving around 1,900 companies. The second is located in Florianópolis, where technology-based companies are concentrated, alongside universities and reference centers for advanced technologies and innovative technologies. From 2013 to 2017, the ISI provided more than 60,000 hours of service in research, development and innovation projects and more than 1,000 companies were served.

The SENAI Institutes of Innovation service delivery for companies lies in what neo-Schumpeterian authors argue that interactions between actors participating in an innovation system are essential for these to occur. In this context, an important research purpose is to study the existing interactions between SENAI's research institutes and industrial companies, aiming at understanding the elements that foster the innovative process resulting from these interactions.

In order to meet this purpose, this text is developed in six sections. On the 1st section is the introduction, composed of the problematization and presentation of the research purpose; the 2nd section presents aspects of the theoretical-analytical framework on innovation in the neo-Schumpeterian perspective; the 3rd section describes the methodological procedures adopted to carry out the research; the 4th section characterizes the SENAI Innovation Institutes; the 5th section analyzes the interactions of the SENAI Innovation Institutes with the selected companies, considering the context of the innovation system, knowledge, learning, and routines; and the 6th section presents the final considerations.

## 2. Theoretical-Analytical Treatment: Innovation in the neo-Schumpeterian perspective

### 2.1 Innovation System and Pro-Innovation Interactions

The National Innovation System (NIS) is a key concept in the neo-Schumpeterian theoretical framework for addressing the innovative process. Innovation is considered systemic, involving different actors who articulate and interact in favor of technical change. Therefore, it is composed of a network of institutions belonging to the public and private groups that act to create, import, modify, and disseminate new technologies through their activities and interactions (FREEMAN, 1987). Along the same lines, for Edquist (2006), NIS is composed of economic, social, political, organizational, and institutional actors, with relevance for the dissemination and use of technological innovations.

The concept of Innovation System can be understood as a set of articulated factors capable of promoting development, in a historical process, through the creation, expansion, and maintenance of an innovative environment. This process is not reproduced in time or space, and its construction is necessary for innovation to assume a competitive differential role in countries that aim to economically stand out in relation to others (CHAVES, et al., 2012).

According to Lemos and Cario (2017), the concept of NIS should be expanded to a territorial assessment, justified by the differences in terms of culture, public policies, and economy in each region, justifying the existence of Regional Innovation Systems (RIS). RIS have a similar structure to the NIS, constituting a social system that presents interactions between different sets of public and private actors in a systematic way, establishing an interaction pattern capable of increasing and improving the learning capacities located in a certain region (ASHEIM et al., 2019; COENEN et al., 2017; ISAKSEN; TRIPPL, 2016).

The benefits of geographical proximity are strongly linked to existing knowledge in regional innovation systems, which circulates locally, rooted in local communication networks involving geographically close different agents (GARCIA, 2021; GARCIA et al., 2020). The advantage of RIS is that the actors are geographically located in the same area and share a common set of values and culture, facilitating the occurrence of knowledge exchanges that accelerate learning processes (CARIO et al., 2022).

In this perspective, different interactive arrangements of the participating actors occur under an innovation system located at national and regional levels. These interactions generate learning that result in the improvement of practices and establishment of long-term planning, aiming at the country and the region to better position themselves in competitive terms, with innovation as a transforming factor.

A highlight in interactive arrangements, the links that are established between industries and universities and research institutes. The interactions make it possible to develop not only services (technical assessments, project management, testing and engineering services), but also consultancy; and collaborative research and development projects (FERNANDÉZ-ESQUINAS, et al., 2016; MOWER.; SAMPAT, 2009). For this purpose, according to Couto and Silva Neto et al. (2012), in the technological field, companies usually do not have all the necessary resources to innovate, therefore needing to acquire knowledge from external sources, such as universities and public research institutes, made possible by the constituted institutional arrangements.

Along the same lines, the State role within the scope of an innovation system is highlighted. Through its interactive practice with the market and society, the State assumes relevance, not only for establishing an innovation policy, but also as having promotional instruments available, via agencies dedicated to the promotion and execution of science, technology, and innovation policies (MAZZUCATO; PENNA, 2016). In addition, according to Freeman and Soete (2008), Mazzucato (2014) and Santos (2014), the State role in the coordination and execution of long-term public policies has been fundamental and explains the development of many contemporary technologies, since the contribution of sums of resources, in the development of innovations, came from the State.

## 2.2 Knowledge, Learning, and Organizational Routines

Knowledge is defined as information that has been authenticated and considered true, thus being essential for establishing competitive advantages for companies and regions (ALAVI; LEIDNER, 2001; TATSCH, 2008). Regarding the insertion of knowledge in innovation systems, Asheim and Isaksen (2002) explain that non-economic transactions help in economic growth and, therefore, by bringing together companies with different skills and knowledge bases, these alliances create unique learning opportunities for partner companies, which make up the national, regional, or local innovation systems of a country.

Partnerships involve sharing resources, infrastructure, skills, routines, and knowledge. Pereira and Dathein (2012) understand this shared knowledge and technological learning as the result of internal relationships (individuals with each other and with the company) and external relationships (with other organizations and institutions), demonstrating that the production and assimilation of knowledge are important for the survival of an innovative environment. In this context, institutions are characterized as the central agent of innovation, as they are capable of accumulating knowledge, which is the main productive input of constant innovations.

However, for Figueiredo (2004), institutions are not the locus where knowledge and technological capabilities reside, but people who have technical knowledge. Thus, it is worth mentioning that, while explicit knowledge is easily systematized and communicated in the form of concrete data or codified procedures, tacit knowledge is the main interest for institutions, due to the difficulty in obtaining and transferring it. And it is this tacit knowledge that provides the organizational action capacity (INKPEN, 1998).

According to Lundvall and Johnson (1994), knowledge is an important economic resource and is classified into four categories: Know-what, know-why, know-who, and know-how. The know-what knowledge type is knowledge about facts, that is, information that can be transformed into data. Know-why relates to knowledge around the principles and laws of motion in nature, in human mind, and in society. This knowledge has proved to be important in making technological development more effective in certain areas of basic science, such as the electrical, electronics, and chemical industries.

Know-how is essential in economic activities and comprises the ability to do something specific, based on patterns linked to learning and individual experiences. The know-who is the knowledge whose information relates to "who knows what" and "who knows what to do."

According to Figueiredo (2004), technological learning is a process that allows the company to accumulate technological capacity over time. It can be developed in two stages: The first refers to the trajectory of technological capacity accumulation; and the second, to the different ways in which the tacit knowledge of individuals is transformed into physical systems, processes and production, procedures, routines, and products.

According to Malerba (1992), the learning processes are: learning by doing, learning by using, learning from advances in science and technology, learning from inter-industry spillovers, learning by interacting, and learning by searching. Learning-by-doing is a learning mechanism internal to the organization and is related to new ways of doing things, linked to the production process. It is based on the worker's experience, capacity, and knowledge in promoting technical changes. Learning-by-using occurs through the use and consumption of the product, creating conditions for continuous changes, as the market's response points to their need (TIGRE, 2005).

The merging of learning by doing and learning by using mechanisms originates learning by interacting. It results from the qualified information exchange between the producer and the consumer (ROSENBERG, 2006). Learning to interact with suppliers generates flows of technological information and innovative partnerships. Learning by searching comes from the processes of searching for information and activities that occur in R&D in the solution of problems and in the aggregation of new knowledge. Learning from advances in science and technology is related to the absorption of new knowledge derived from the national and international S&T system (MALERBA, 1992; TIGRE, 2005; AZEVEDO, 2016).

Clarifying the relevance of knowledge and learning in the development of innovation reveals the importance of routines, which are considered the genes of companies. For Milagres (2011), routines are repetitive patterns of subject behavior in the face of context variations, and they constitute rules (operating procedures) according to which companies act. They can be defined as collective dispositions, which lead agents to practice previously acquired behaviors, and can be understood as a repertoire of behaviors.

Within individuals, it can be said that routines come from skills and habits. Regarding the organizational perspective, routines exist to minimize conflicts, maintain coordination, reduce uncertainties, incorporate knowledge, and reduce the use of cognitive resources. Routines constitute a set of tools that help management in times of crisis, also guiding the selection and interpretation of information received from different sources (NELSON; WINTER, 2005).

In the neo-Schumpeterian theory, the reading of routines is based on the understanding that companies are in an environment marked by imperfect information and non-predictability regarding the results of the chosen strategies. Agents, especially under uncertainty, will follow a set of rules. Therefore, according to Costa (2016), companies develop routines that guide them in responding to changes in the environment and in which the knowledge they use in the search for new products, production methods, and organizational and marketing forms is deposited.

## 3 Methodological Procedure

This research is a case study with a qualitative approach, in which we sought to analyze the interaction between research institute and company in its institutional and innovative aspects, based on studies about SENAI Innovation Institutes in Santa Catarina (SC) and Santa Catarina companies (CHIZZOTTI, 2009). Data was collected through bibliographic and documentary research and through semi-structured interviews. For data analysis, we opted for content analysis, with data processing performed using the Atlas.TI qualitative data analysis software.

Three large industrial companies from Santa Catarina that completed innovation projects in 2017 and 2018, and performed more than 100 hours of production, participated in the study. Company 1, identified in the interview as EE1, is part of the automotive sector, has more than 1,000 employees, export goods to 60 countries, has 2,000 products in line, and ended the 2017 financial year with a BRL 200 million turnover. Company 2, identified in the interview as EE2, is part of the durable goods sector, has 14,500 employees in its branches in Brazil and a mean annual revenue of BRL 600 million; it is a subsidiary of a large group of companies. Company 3, identified in the interview as EE3, belongs to the food sector, has 1,400 permanent employees and hires up to 3,000 per year, as required by the sector; it is part of a group of companies that earned BRL 2.8 billion in 2017. The interviewees from the industrial companies were one responsible for R&D and two specialist technicians who participated in the project design with SENAI/SC. Therefore, the number of respondents was of the 6 being 1 Director of ISI (Director of ISI); 2 Technical Specialists from ISI (ET1 and ET2) and Techinical Specialists from companies (EE1; EE2 and EE3).

Data collection was performed on primary data sources via documental analysis and an integrative review; and on secondary data sources, through the application of semi-structured interviews with the main actors of the innovative process between the SENAI Innovation Institutes and companies from Santa Catarina. Content analysis was carried out according

to Bardin (2016), based on the interviews, which were carried out with the main actors in this process, with the purpose of understanding how the interactions of the research institutes with the companies occurred, aiming at the development of innovative processes, and how organizational and institutional processes occurred in these interactions.

**Table 1 - Dimensions of analysis, theoritical-analytical perspective and categories of analysis.**

| Analysis Dimension | Theorical-Analytical Perspective | Analisy Categories |
|---|---|---|
| Discuss the main elements of the evolutionary theory of the innovaion system | Innovaion system | Geographic promity<br>Role of the State the development of ST&I<br>Actors innovaion system |
| Analyze the existing institutional framework in the SENAI Reserarch Intitute and companies interatctions | knowledge | Know-what<br>Know-why<br>Know-who<br>Know-how |
| | Learning | Organizational learning<br>Techonological leaning<br>Techonological capacity |
| | Routines | Individual routines |

Source: Elaborated by the authors.

The categories of analysis were divided according to the dimensions of analysis, based on the study purpose. The first addressed the geographic proximity between the ISIs and the companies; the second, the role of the State in the development of ST&I; and the third, the actors of the innovation system, who contributed to the development of the projects. Then, in order to understand the existing institutional framework in the interactions between the research institute and the company, having as analytical perspectives, first, knowledge was evaluated with the following categories of analysis: Know-what, Know-why, Know-who, and Know-how. In the second analytical perspective, it was verified how learning occurs in the organizational and technological areas. Finally, the routines were evaluated from organizational and individual perspectives, according to Table 1.

Data analysis and processing was carried out using the Atlas.TI qualitative data analysis software. For content analysis, Atlas.TI has statistical tools, such as the repetition count of terms or words in several documents to confirm the existence of an analysis category that was studied and allowed a more consistent inference and interpretation. For this purpose, this tool was used, allowing the construction of relationship maps of the most mentioned terms in each of the analysis categories.

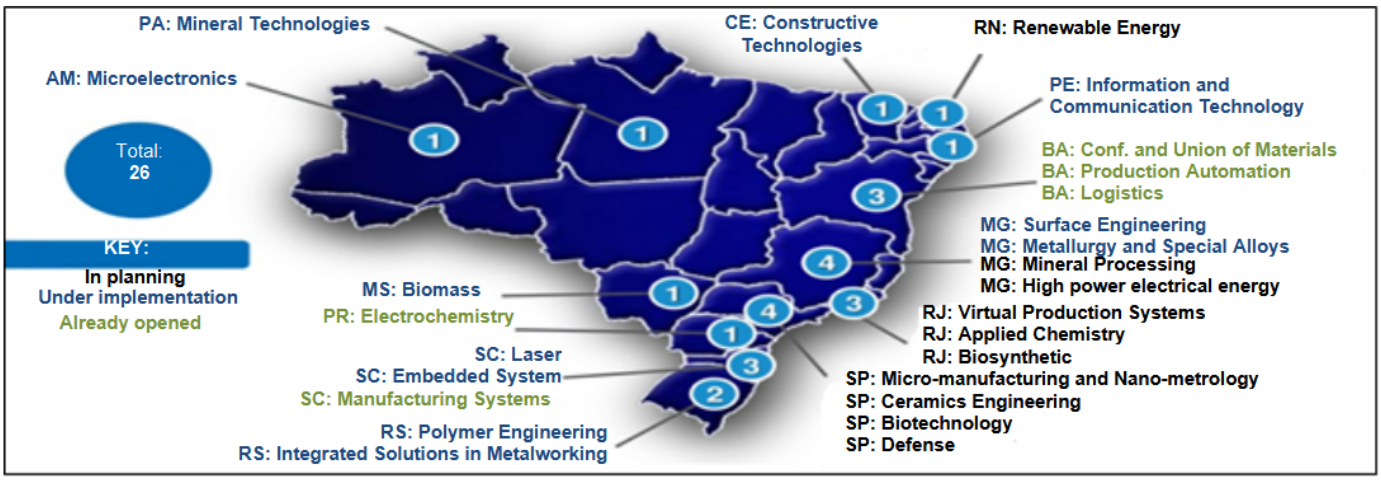
## 4. Characterization of SENAI Innovation Institutes

National SENAI has a long history as an institution belonging to civil society; it is close to completing eight decades of existence. The vision and the work plan that National SENAI, together with each federation SENAI, created are structured in line with policies elaborated by the Federal Government for the expansion of Science, Technology, and Innovation areas in Brazil. The outstanding project of SENAI is in this setting, the creation of the SENAI Innovation Institutes (ISIs) and SENAI Technology Institutes (ISTs) with the purpose of product and process innovative development and the capacity to provide technological services for the industries.

The ISIs are installed close to industrial and university complexes, with the aim of facilitating the flow of scientific and technological knowledge. There are institutes in the five regions of the country, located in the states of Amazonas, Pará, Pernambuco, Bahia, Minas Gerais, Rio de Janeiro, Mato Grosso do Sul, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul. Such institutes were created to provide tailored, innovative solutions to the needs of the industry. Its focus is on applied research, which consists of developing innovation projects using knowledge to create new products and customized solutions, or ideas that generate new business opportunities (SENAI, 2018).

Six of the 25 SENAI Innovation Institutes in the network are accredited by EMBRAPII, and their initiatives have differentiated resources for project financing. Institutes still develop projects with resources coming from: Direct investments by companies; financing through the Notice of Innovation for the Industry; or other regional and national sources of research and innovation promotion. The projects developed by the institutes are monitored so that the proper quality in the provision of services can be guaranteed; they are also developed with the application of project management methodologies, so that deadlines are met as contracted by the industry (SENAI, 2018).

**Figure 1 – Location map of SENAI Innovation Institutes – Brazil.**




Source: SENAI, 2018.

The location of each institute was planned according to the areas of activity and knowledge of each state. Each of the institutes has technological platforms, which are the areas of action, and these areas are developed and planned according to the competences of the institutes and the needs of the Brazilian industry (SENAI, 2012).

In Santa Catarina, as seen in Figure 1, there are three ISIs: 1st) ISI in Manufacturing Systems, focusing on manufacturing technology and production processes, engineering of mechanical materials, and development of metalworking products); 2nd) ISI in Laser Processing, active in laser cutting methods, laser additive manufacturing, laser welding methods, laser surface technologies, and system technology and process control; and 3rd) ISI in Embedded, Systems, with development in control and optimization, communication systems, signal processing and data mining, and verification, simulation, and quality management.

## 5. Analysis of the Interactions between SENAI Innovation Institutes and Selected Companies

### 5.1 Innovation System: Actors, functions, and importance

An innovation system (IS) of a country or region is composed of economic, social, political, organizational, and institutional actors, considered relevant for the diffusion and use of technological innovations (EDQUIST, 2006). For Freeman (1987), the NIS is composed of a network of institutions belonging to the public and private sectors, which act in order to create, import, modify, and disseminate new technologies through their activities and interactions.

The actors of an IS relate to each other, creating a propitious atmosphere for the development of innovations through their economic, social, and cultural relations. In this context, the representatives of the researched companies, in this study, identified some actors of the NIS and RIS, who participated in the innovation projects carried out from the interaction between ISIs and companies. These actors were Universidade Federal de Santa Catarina (UFSC), Universidade do Estado de Santa Catarina (UDESC), State, Empresa Brasileira de Pesquisa e Inovação Industrial (EMBRAPII), Financiadora de Estudos e Projetos (FINEP), Banco Nacional de Desenvolvimento Econômico e Social (BNDES), Associação Catarinense de Tecnologia (ACATE), and Centro de Referência em Tecnologias Inovadoras (CERTI).

In the understanding of the researched companies representatives, the mentioned institutions constitute bridges between the research institutes and the companies. Specifically, they point out that the State must work to maintain a more stable macroeconomic environment, thus reducing economic risks. EMBRAPII, BNDES, and FINEP are institutions that encourage innovation by directing funds to the development of new projects. The universities, in turn, appear as partners of the institutes in the discovery and investigation of new technologies, while ACATE and CERTI appear as institutions that cooperate in the development of projects as important partners.

According to the Director of ISI in Embedded Systems, institutions such as FINEP, BNDES, ACATE, CERTI and the State Government are important players in the innovation system that seek to interact to foster the development of innovations and enable economic growth for companies in the state. Thus, he stated as follows: "[...] at the national level, there are other ties with FINEP and BNDES, very strong. [...]. We are seeking alignment with ACATE, and we already have some interaction with CERTI, but we need more, with the State Government itself" (D1).

For the SENAI Technical Specialist, the university is a great partner in the development of innovation projects, becoming a key player in the innovation system. Proximity to this actor makes it possible for the ISIs to be a link, bringing universities and companies closer together in the development of new knowledge and new technologies. Therefore, the interviewee states,

"[...] we do have relations with universities, UFSC, we have with UDESC, with Univille, with the Pontifícia Universidade Católica do Rio Grande do Sul, with the Catholic University here from Joinville, a relationship with Universidade Federal do Paraná and the [Universidade] Técnica Federal do Paraná" (ET2).

Regarding the role that the State plays in the development of science and technology, it was evident, in interviews with both company representatives and ISI employees, that the sharing of financial risks is a preponderant factor in contracting innovation projects. Therefore, the State assumes the role of risk taker, when it develops initiatives to promote innovation through EMBRAPII, for example. It is observed that, first, the companies look for a source of support for project funding, and, in cases in which there is none, the possibility of using their own resources is studied. Thus, there are the statements, "Usually, we look for a source of funding first, if we do not find it, we choose to use our own resources" (EE1); or this one, emphasizing the importance of the counterpart, "For the entrepreneur, it is a huge risk that they are not always willing to take. So, the counterpart, it is necessary" (EE3).

The transcribed reports follow the idea expressed by Mazzucato and Penna (2016), when they point out that facing innovation challenges requires investments from both actors, the public and private, with the public sector, in this case, having major importance in the first stages and in the capital-intensive venture areas from which the private sector tends to walk away. Such support is fundamental, considering the uncertainty of the innovation process, since the actors committed to innovation cannot, in advance, calculate the probability of success or failure. As the results are unknown, it is necessary to accept the occasional failures and deviations from the plan. Therefore, the State is considered an important actor to jointly assume risks and develop innovations.

In this context, the Director of ISI in Embedded Systems points to the need for adequate public policies that encourage the innovation development. Thus, it would be crucial for the country to have basic funding to finance projects. The interviewee points out, "The funding source helps a lot, it drives a lot, it is very essential. [...] it is very difficult to carry out R&D without an adequate public policy" (DI). And he complements stating that, in Brazil, in the absence of strong public policies for the innovation promotion, the EMBRAPII initiative and other innovation notices end up playing the role of innovation funders. The shares of this institution "end up working, in part, as basic funding, but, let us put it that way, it is not. For the system, it is absolutely essential to reduce the risk of companies" (DI).

Along the same lines, ISI Technical Specialist 2 states that, for companies, it is important to have someone to share the risks surrounding the innovation development. Companies such as EMBRAPII and BADESC are important for helping and promoting these projects. The funding sources, together with SENAI's ISIs, bring support and security to companies that search and find support to develop innovation projects. Therefore, "Having possibilities to manage and share this risk brings a little more security, and I believe that it acts as a motivational factor for companies to start investing more in research, knowing that there is support, that there is something to rely on, that there is no need to enter this mission alone and with a very big risk involved" (ET2).

In addition to the aforementioned macro-institutional aspects, which make up an innovation system, the geographic proximity in which the actors are located also stands out. According to Cario, Lemos and Bittencourt (2016), the advantage of a regionally based innovation system allows actors who are geographically located in the same area to share a common set of values and culture, facilitating face-to-face interaction, thus allowing the knowledge exchange that accelerates the learning processes. Garcia et al. (2014), in their study, complement stating that the geographic location of the actors in the innovation system interferes with the success of innovation projects between industries and research institutes.

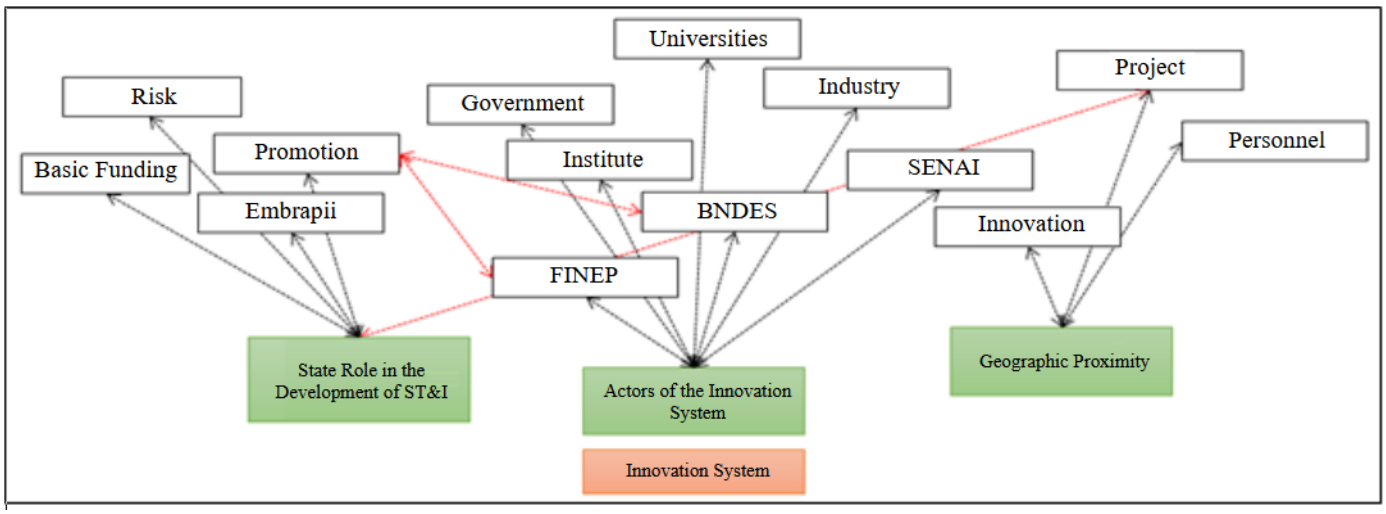
In the interviews, it was reported that the ISIs are strategically located in the regions with the highest concentration of companies related to the area of knowledge in which they operate. Strictly speaking, the location of the institutes was strategically thought out by the institution to be close to the companies with the greatest similarity in their knowledge, thus creating a favorable environment for companies to innovate. According to the Director of ISI in Embedded Systems, this institute is located in the region with the highest concentration of technology-based and information technology companies in the State of Santa Catarina, in addition to being established in a region where a large number of trained people predominate, especially from UFSC. The transcribed statement confirms this observation, "ISI in Embedded Systems is part of the DNA of this region, and, with that, causes an overflow of knowledge between companies, universities, and institutes. There are overflows, spill-overs, spin-offs, and all these things that go and exceed" (DI).

Such consideration is in line with Garcia (2021) and Garcia et al. (2020) who point out that the benefits of geographical proximity are linked to knowledge and the learning processes that feedback. This knowledge circulates at the local level, rooted in local communication networks and in forms of interactions, involving different agents who are geographically close. With the geographical proximity, the levels of trust between institutes and companies are stimulated and allowed, providing, at the regional level, partnerships that contribute to the development of innovative processes as these interactions occur.

Reports from the interviewees in this study point out that geographic proximity brings advantages in monitoring and solving the problems of innovative projects. Being physically close to the ISIs facilitates communication and interaction throughout the project. As reported by the specialist of one of the interviewed companies, the proximity to the ISI facilitates

interactions and the dynamics of prototype development, allowing a certain speed in adjustments and in cases of need for changes during the course of the project. Thus, it was possible "[...] with a certain frequency, especially at the end, to see the equipment in loco, check what was there, if anything needed to be changed from what had been defined and such. As it is close, we would go there, go in and see how it was, what was not there, what needed help or not" (EE2).

**Figure 2 – Analytical perspective of the innovation system and analysis categories – relevant actors, State role in the development of ST&I and geographic proximity.**




Source: Prepared by the authors, 2022.

Figure 2 shows the main considerations of interviewees regarding the importance of actors in the innovation system, the State role in the development of ST&I, and the relevance of geographical proximity in the interactive processes between research institutes and companies. In the actors in the innovation system analysis category, BNDES, FINEP, and universities were the most cited, followed by industries, the Government, and institutes. With an emphasis on the ISIs, in the interviews, it was pointed out that the existing partnerships with the other actors have effectively contributed to the development of an innovative environment.

Regarding the State role in the development of ST&I, the function of mitigating risks through the availability of funding sources was highlighted, which provide companies with a greater possibility of investing in innovations. Therefore, the government, BNDES, and FINEP funding sources were highlighted by credit lines specific for innovative projects. In the evaluation of the terms referring to geographic proximity, the following benefits were highlighted: Agility in the project development, presence of personal technical capacity for innovation, and greater occurrence of interaction with universities and research institutes with companies.

## 5.2 Types of Knowledge: Forms of manifestation

According to Lundvall and Johnson (1994), the know-what knowledge constitutes knowledge about facts, called information. From the companies' point of view, we identified in the interviews the way in which the transfer of knowledge and concepts related to the studied themes in the project development takes place. For the business representative, the current concepts of Artificial Intelligence, Internet of Things, and Industry 4.0, passed on by ISI during the project development, added value and expanded the knowledge of the company's team: "Artificial intelligence, for us, we did not have it incorporated into our daily lives. [...] Then the internet of things, artificial intelligence, industry 4.0, these concepts that, at the university, we saw in an academic way, we managed to learn a lot about it from them, and it added a lot for us and the company" (EE3).

Regarding the ISIs' point of view, we observed that the transfer of knowledge generated by the institutes to the companies occurred throughout the project, so that, in the end, the companies would know how to operate and/or manufacture the prototypes developed during the innovation project. The transfer of this knowledge took place through meetings, reports, videos, in addition to informal interactions by telephone and hangout during the course of the project.

For the Director of the ISI in Embedded Systems, if, at the end of the project, the company does not know how the technology was developed, the project, although completed, have not had the expected success. Therefore, to guarantee its success throughout the project, information is passed on to validate with the company and many tests are carried out to guarantee that the final results will be delivered, "What we do here, the company participates. As we are preparing the project, we are passing it on, they are following the project, but they are analyzing all the time if it is in line with what they need and if our solution gets in the way at some point. And we carry out tests and more tests, passing on the necessary information" (DI).

According to the interviewees, knowledge was passed on throughout the project, highlighting that knowledge and information on how to develop or manufacture the prototype were transferred. Thus, the answers obtained in the interviews

corroborate the words of Lundvall and Johnson (1994) that the information and knowledge transferred are materialized in data, prototypes, products, etc.

According to Lundvall and Johnson (1994), the Know-why knowledge refers to knowledge about the principles and laws of natural, social, and scientific knowledge. It can be obtained through books or via queries to the database, which can be codified and transferred as information, being more connected to the strand of scientific knowledge proposed by Engineering, Chemistry, and Physics, for example. Therefore, the principles and basic laws of these areas of knowledge have taken more space regarding technological innovations, enabling the creation and development of new products.

During the development of the interviews, we identified different perceptions between the companies and the ISIs. For the companies' interviewee, it was the company's employees who provided the basic knowledge, principles, and laws for the elaboration and composition of innovation projects. According to the company's specialist, ISI had to learn how the dynamics within the company worked; resorting to the scientific knowledge obtained and adding new knowledge achieved throughout the development of the project, "There is a learning process. It is one thing when you work academically, and another thing when you work in the industry. They have industry interference on top of a project. But one ends up learning within the project. However, when initially developing, the roots of scientific knowledge are sought to be applied here within the industry" (EE3).

For the interviewees of the ISIs, the principles and basic laws of Physics and Chemistry were provided by the universities, in addition to, internally, the undergraduate, master's, and doctoral fellows contributing with this knowledge. According to the Director of ISI Embedded Systems, the participation of universities is essential for the development of nature laws and principles. It is the universities that carry out academic research, while the ISI takes on the development of innovations with companies, that is, "We need the university. So, what is our basic idea, to bridge the gap between basic research, which is carried out at the university, and take this to industry. [...]. We interact with teachers. Today, our strongest interaction today is with three universities, UFSC, ITA, and with the Institute of Mathematics and Computing Sciences at USP" (DI).

This perspective, according to Lundvall and Johnson (1994), is important for technological development in certain areas of the basic sciences. In the speech of the ISIs interviewees, it was clear that universities play an important role in the formation of this knowledge and basic principles of Physics and Chemistry that are necessary for the elaboration of the most complex innovation projects, which permeate the frontier of knowledge.

Know-who, according to Lundvall and Johnson (1994), is the type of knowledge that covers *who knows what and who knows how to do what*, including the social skills that allow cooperation and communication with colleagues and collaborators. For Santos (2009), this type of knowledge is essentially tacit and built through processes of interaction, once again having a place of fundamental importance.

According to one of the companies' interviewees, the sources of information or training used for the development of innovations are: Consultancy, promotion of forums to discuss relevant topics, and sharing of internal knowledge. In his statement, he says, "We use consultants, including outside consultants, to help us with some issues that we do not have much experience with. [...] the company promotes some forums here. [...] we have an internal knowledge sharing project. [...] It even promotes internal training, sometimes someone participates in training, acquires knowledge, disseminates it within the company" (EE1).

For another Specialist from the company, EE2, the acquisition of new knowledge is done in partnership with universities, with suppliers; through research on the internet, participation in fairs, and visits to other company branches, which are scattered in other parts of the world and develop different products, allowing new knowledge. That is, "[...] these are partnerships with universities, different types of universities, partnerships with suppliers that bring us a lot of technology on visits, fairs... This also brings us input technologies. [...] we have other prototype areas around the world and, some, we have visited and have always exchanged an experience of what is being developed there or what we develop here" (EE2).

For the ISI interviewees, however, the sources of new knowledge are related to technical visits to other countries, the hiring of reference professionals from universities and large companies abroad, and the exchange of experiences in the ISI network. In this regard, it is emphasized that, "I brought someone here from MIT, with whom I worked when I was there. Also, I brought a French teacher, with whom I worked in France. I brought people from ITA, Microsoft, too. [...] it does not have an established periodicity" (DI).

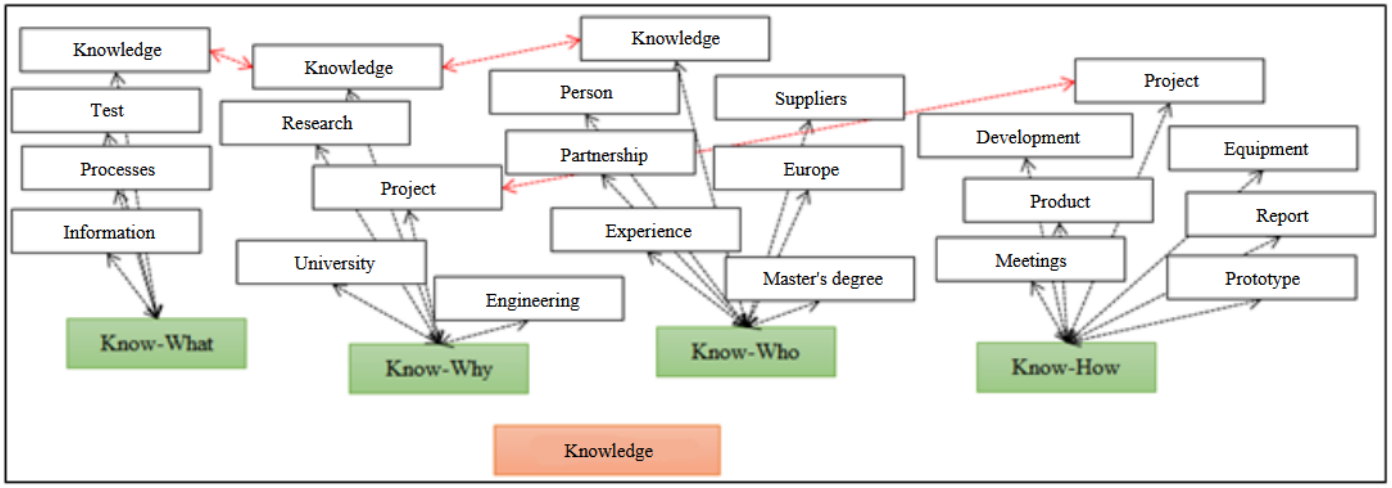
In this type of knowledge, the essential thing is to know the right person and their capabilities. Therefore, personal skills from different areas of knowledge (engineer, chemist, physicist, economist, administrator) come together in pursuit of innovative development. The interviews showed that companies and ISIs also acquire new knowledge through people who are references in different areas of knowledge and different professional activities.

According to Lundvall and Johnson (1994), know-how is the knowledge of capabilities and skills on how to do different types of things. This is the type of tacit knowledge, very much associated with the "to do" ability of workers. It is the experience gained over time, through relational learning, in the context of workplace interaction. They are, finally, the skills,

competences, technique, and way of doing things of an individual. In the present study, we identified that the ISIs carry out this process, and that the companies understand the importance of having this transfer through a formal means, so that later they can replicate that solution and develop a new product.

It was evident in the interviews with the ISI collaborators that the researchers' know-how is the most essential knowledge, the one that cannot be passed on to a third party. As much as the ISIs have processes and procedures for the transfer of knowledge between researchers, even so, this transfer is not carried out in a way that the knowledge stays in the ISIs. The closest thing to a codification of this knowledge occurs through the elaboration of a final report containing the history of the project, which is delivered to the client. As stated by the business representative, "The transfer of know-how occurs throughout the project, we have several alignment and progress meetings where the company is always consulted, and the results are always presented to the company. Reports are prepared, where we summarize all the developed experimental part, the difficulties, advantages, results obtained, so that the company understands what was done" (ET2).

**Figure 3 – Analytical, theoretical perspective of knowledge and the know-what, know-why, know-who, and know-how categories of analysis.**




Source: Prepared by the authors, 2022.

In Figure 3, the main words cited by the interviewed actors on the importance of knowledge for innovative processes are presented in their different expressions. Therefore, it is demonstrated that the know-what is more linked to the systematization and codification of data and information, and the most cited terms were: Test, processes, and information. While know-why is related to knowledge, principles, and laws of physics and chemistry; the most cited terms were research, project, university, and engineering. The sources of knowledge used in the know-who for the development of innovations were suppliers, partnerships, and the hiring of professors from external universities. Finally, the know-how of the ISIs was transferred to the companies during the development of innovation projects through meetings and reports delivered, in addition to the transfer of the developed prototypes.

## 5.3 Learning Mechanisms: The organizational and the technological

Organizational learning constitutes an individual and collective process of investigation (identification and analysis), which can also be defined by the development of ideas, of knowledge, associations between past actions, the effectiveness of these actions and future actions. Organizations develop and maintain learning systems that not only influence their members, but also transfer over time through norms, culture, and organizational histories. The representative of Company 1 mentioned, throughout the interview, that the development of the innovation project resulted in learning for the company, so that the employees were able to operate the developed test bench, given that new norms and procedures were introduced in relation to what was being done.

There was also another type of learning, the technological learning, which, according to Figueiredo (2004), refers to the process that allows the company to accumulate technological capacity over time. These technological capacities relate to the various processes by which the tacit knowledge of individuals is transformed into physical systems, with this accumulation of technological capacity process occurring in companies and ISIs, during the development of innovation projects, with the elaboration of prototypes, as well as with the delivery of reports, videos, and documents that the ISIs developed throughout the project, with the aim of safeguarding all the developed knowledge.

Within the scope of technological learning there is also the presence of other forms of learning, as pointed out by Malerba (1992), such as the learning-by-doing process. Learning-by-doing is a common learning mechanism consisting of a form of knowledge and skill acquisition, based on the experience of researchers and operators, and it is considered a passive and automatic process (PEREIRA; DATHEIN, 2012). In this context, the interviewee from Company 1 reported that the change in the way of carrying out their processes enabled operators to gain and improve knowledge in the operation of the test

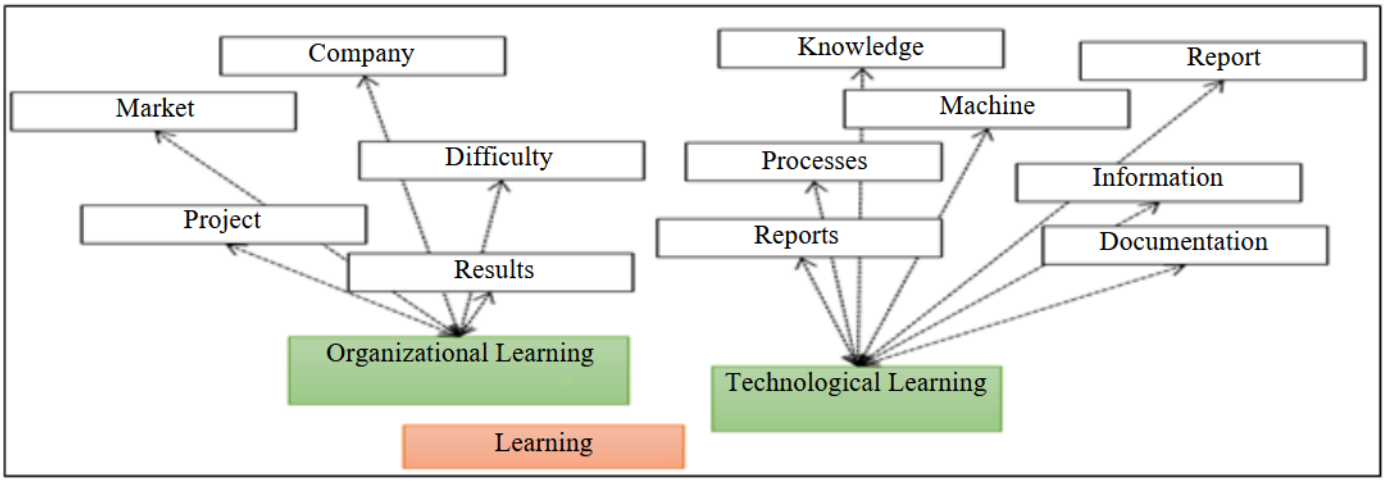
bench, delivered from the project signed with SENAI's ISI.

Learning-by-searching is the process that occurs through research; it is inherent to the execution of the innovation projects in the ISIs with the companies. Both the researchers from the institutes and the company's technical team stated that they share the knowledge acquired during the project development. This knowledge is converted into a physical system – prototypes. As they are being developed and delivered to the company, they are converted within the company, when they are successfully developed.

Still regarding the learning-by-interacting process, the occurrence of learning arising from the relationship established between companies and ISIs is registered. In this context, the transfer of knowledge generated throughout the project is observed, and sometimes the occurrence was informally manifested through conversations and meetings between researchers and representatives, and, formally, with the submission of documents – reports – generated at the end of the project.

In the interviews carried out with the companies' representatives, the informal transfer of knowledge generated during the project through conversations and meetings was described, "During the project there was an informal conversation, but there was already a transfer of knowledge. Many things that you brought us ended up modifying or... from experience, in practice, it was a partnership project (EE1). The formal product delivery took place through the delivery of materials, videos, and technical drawings throughout the project, so that, in the end, it would be easy to gather all the intermediate deliveries and, thus, assemble the final report for the client. Therefore, "You have a simple report, nothing too voluminous, very straightforward with presentations: Images, videos, and experiences. And that adds up to the documentation of the final project. The final report is the accumulation of everything you have been doing" (ET1).

**Figure 4 – Analytical, theoretical perspective of Learning and Organizational Learning and Technological Learning Categories of analysis.**




Source: Prepared by the authors, 2022.

Figure 4 illustrates technological learning as converted into physical systems through the knowledge generated in project development, as well as how this knowledge is incorporated by companies through machines, processes, reports, and documents that are delivered to the customer at the project completion. Organizational learning was approached as a process with greater difficulty to occur, since, for this, it is necessary to change the routines and work patterns of companies. With the incorporation of a new test bench for Company 1, it was verified that there was a significant change in relation to its current production process.

## 5.4 Organizational and Individual Routines

According to Nelson and Winter (2005), routines are defined as stable patterns of behavior that characterize organizational reactions to external and internal stimuli. Within the routines mentioned by the interviewees, the organizational routines stand out, especially those that occur in the Legal Department, when the contract is being drawn up and evaluated. In the business field, these tasks rely on the participation of the company's technical team, as expressed by a business representative, "Here, any contract drawn up goes through the legal department" (EE1). At the ISIs, the process of drafting contracts initially passes through the sales team, which makes initial contact with the customer. After understanding the demand, the contract is sent for evaluation by the technical team (technical specialist, coordinator or director of the Institute), which, in sequence, sends it for the issuance of the commercial proposal and, finally, it is forwarded to the company.

Once approved, the contract is forwarded to the legal department in order to prepare a cooperation agreement that is subsequently signed by the Regional Director of SENAI/SC. For covenant cases, the legal department assesses the document for subsequent signature by the Regional Director of SENAI/SC, as well as the President of FIESC. For cases of commercial proposal for direct sale, the director of ISI has the power to sign the contract together with the person responsible for the

company.

Regarding project negotiation time, for direct sale cases, the deadline is one week to write the project, and then it takes, on average, three months to finalize negotiations with the company. For covenant cases, this deadline is around one month for the elaboration of the work plan and from three to six months until the conclusion of the negotiation between the parties, in the case of a project with EMBRAPII; and twelve months if it is with Agência Nacional de Petróleo (ANP), as reported by one of the interviewees, "It depends on the project, on the proposal. For the EMBRAPII project, it is about three to six months. For projects with the ANP, the deadline takes twelve months" (ET1).

Regarding the issues of penalties and secrecy clauses, both the respondents of the companies and the Institutes highlighted the importance of rules, so that they can protect themselves from an eventual information disclosure. Therefore, the business representative states, "There has to be secrecy because, usually, these are innovation products that we are dealing with (EE1); and the representative of the ISIs, "We pass on the importance to the researchers and the work team, of course, careful with secrecy" (ET1). In this case, it is a tacit agreement, since SENAI/SC does not accept clauses with financial penalties in its contracts; and the ISIs and the companies work in cooperation, and, therefore, do not pay financial fines.

For the ISI interviewees, changes throughout the project were foreseen, considering the complexity and characteristics of innovation projects, as well as their duration and the changes in the economic scenario, "An innovation project, over its one year, two, three years in the making, will hardly go exactly as planned in the original scope. During this period, a lot changes, the economic situation, politics, that is, not only are internal factors, but also external factors influencing the project" (ET2).

As a result of the decision-making process of the paths that will be taken during the project, both the companies and the ISIs interviewees answered that the decision of the choices rests with the company. After all, it is the company that knows its challenges and needs, so, whenever necessary, the ISI reported deviations, and the company defined and decided on its choices. In this context, the ISIs interviewees mentioned that a solution matrix is prepared, listing the gains and losses with each of the proposed solutions, and the final decision is up to the company. The ISIs role is to think and present the options, leaving the company to evaluate and define the project development. This process was described as follows, "A decision matrix is elaborated. So, we put in some indicators. And these indicators are agreed, for example, time, cost, value, importance, challenge, difficulty degree, and we give a score together with the company, and the company makes the decision" (ET1).

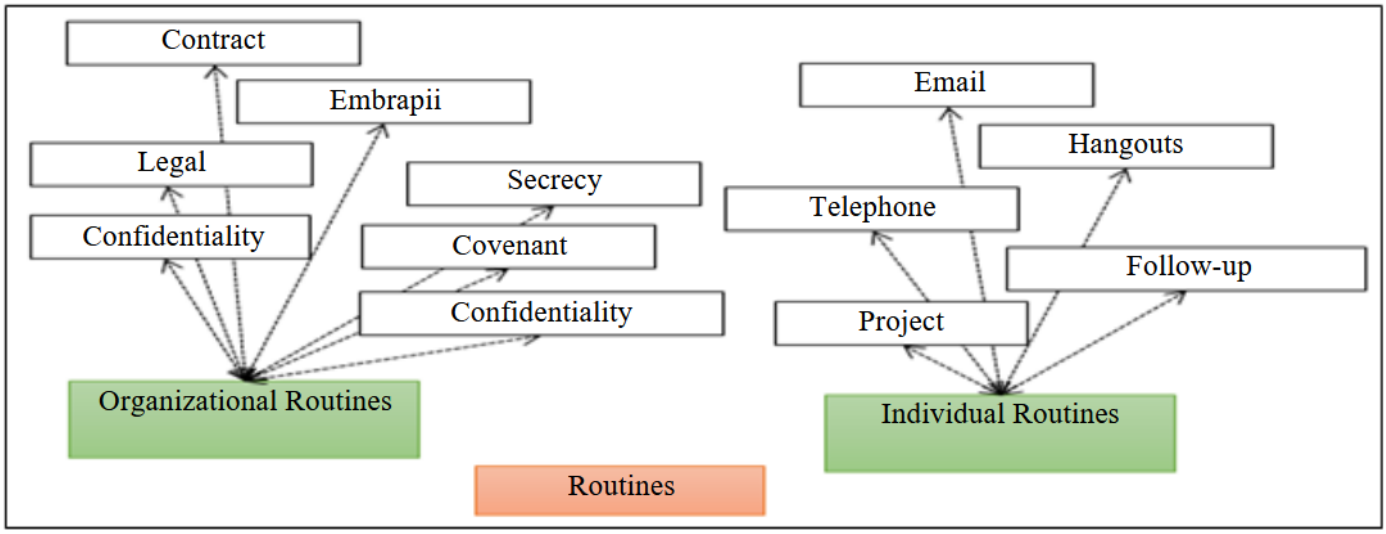
Emphasis was also given to individual routines within the scope of interaction between ISIs and companies. In this context, routines constitute patterns of behavior in the field of agents that integrate such interaction; establishing values, culture, and experiences among these individuals related to communication between them. The communication between the ISIs and the companies, for the most part, was carried out formally, so that negotiations and the project progress could be recorded. At the end of each stage delivery, a document containing the description of all the development so far was formalized. Interviewees reported that, even after carrying out informal conversations by telephone or other communication tools, the dealings with records were formalized by email.

For the ISI interviewees, it is essential to keep documented as many negotiations as possible, as they understand that, during the course of the project or at the end of it, it is necessary to clarify any doubts, and the institution needs to be protected with the formalization between the parties. Thus, this understanding was recorded, "At each stage it was formalized. I would sign a document acknowledging that that step was performed. It is very methodical. It is right in a project that has to be accounted for" (EE3). And yet, in another record, "And when we are called to give explanations, we need to have documented evidence" (ET2).

In this regard, several tools were used with the purpose of maintaining adequate communication throughout the project, as mentioned by the interviewees, such as: exchanging emails, telephone calls, videoconferences via Hangout, exchanging messages via WhatsApp, and interactions with directories in Google Drive. According to the interviewees, these ICT tools were essential, as they improve relationships, communication, and learning in the project development. The quality of deliveries was related to communication, considering that, if this is not carried out at the right time between the parties, the project development may follow an unwanted path.

Figure 5 helps to better understand the importance in the development of organizational and individual routines based on the interactions performed. Of the most cited terms in the interviews referring to the theoretical-analytical perspective of organizational routines, the contract was the most cited term, considering its relevance to formalize the negotiation of issues, such as term, scope, secrecy, and confidentiality. Other terms presented as relevant were EMBRAPII and covenant, since, according to the technical specialists of the institutes, the negotiation of projects with EMBRAPII resources, unlike the others, involves an agreement process that has a certain rigidity in the contractual terms. Finally, within the scope of individual routines, when asked about the tools used in interactions throughout the project, email was mentioned as the main communication tool for formalizing the dealings carried out by telephone or conversations via Hangouts.

**Figure 5 – Analytical, theoretical perspective of routines and analysis categories – organizational routines and individual routines.**




Source: Prepared by the authors, 2022.

### 5.5 Achieved Results

According to the Director of ISI in Embedded Systems, in the past, companies sought to solve existing technical problems internally, in their R&D departments. However, as the reputation of the work carried out by the Institute grew in the market, countless companies sought interaction with the Institute to develop innovative projects. Most of the developed innovations are incremental, with an emphasis on technical changes that resulted in cost reduction, increased productivity, better machine operation, etc.

When questioned about the obtained results, the representative of Company 1 demonstrated satisfaction with the delivery of the test bench that was developed and which generated savings in production costs, in addition to reducing atmospheric emissions and improving the ergonomics of employees. Thus, says the business representative, "We started to consume less fuel, reduced atmospheric emissions, greatly improved the ergonomics, in which we lift very heavy parts when the operator goes to setup the machine. Now, the mounting position is much easier regarding the engine itself" (EE1).

In the perception of the interviewee from Company 2, in relation to the gains for the company, he reports that it was partial due to the project contracting not having included an operator training clause. The developed machine is stopped and unused. The interviewee agrees that the contract signed with ISI was complied with, however, during the negotiation process, a clause enabling employees to be trained in the future handling of the machine was not specified. The company shows, at the moment, an interest in carrying out an incursion with the ISI to negotiate the training of its employees.

The interviewee from Company 3 cannot mention the project's actual gains, as he depended on the next harvest to be able to use the software developed in conjunction with the ISI and impute production data that would allow verifying the results. However, he mentioned that the tests carried out on the system were positive and that the next harvest was expected to confirm the results obtained in the laboratory. At the time, the expectation was, "[...] the expected results will increase the factory productivity and directly reach the costs, thus, we will improve our performance" (EE3).

## 6 Final Considerations

The purpose of this study was to analyze how the interactions between the SENAI research institutes and the companies were formed in the development of innovative processes in Santa Catarina. Therefore, we used the neo-Schumpeterian authors' theoretical approach, which establishes an analytical framework about innovation and allows understanding the development of capitalism in its evolutionary dynamics, taking into account its historical and interactive nature between agents (COSTA, 2016).

In order to achieve this purpose, the interactions of research institutes with companies in the state of Santa Catarina were analyzed, based on interviews, as described in the methodological procedure item, with actors participating in these interactions. Regarding the **innovation system**, the interviewees' responses indicated the State's active participation in promoting projects, as a preponderant factor for companies to be able to contract the services of ISIs, in view of the inherent risk that projects have in the development of innovations, corroborating with the writings of Freeman and Soete (2008), Mazzucato (2014), and Mazzucato and Penna (2016). In this context, UFSC and UDESC universities, as wells as EMBRAPII, FINEP, and BNDES stand out. In addition, the geographic proximity of the actors was highlighted as a factor for the success of innovation projects, facilitating personal contact between teams and ensuring the necessary dynamism for the development of projects.

Such results corroborate the words of Garcia (2021), Garcia et al. (2020), Broström (2010), and Bittemcourt; Cario (2021).

In the field of evaluating the types of **knowledge** present in the development of interactions, the occurrence of the Know-what type was found, expressed in information exchanged between researchers and operators on the Internet of Things and Industry 4.0 as cited references. Regarding the Know-why type, the diffusion of scientific knowledge in the engineering and physics areas was verified, supporting the decisions in the project development phases. Regarding the know-who type, we observed citations about the specialized knowledge in different areas of researchers higher education, who, cooperatively, sought to find technological solutions. And, in relation to the know-how type, based on the experience and skills of researchers obtained over time, informal processes of occurrence and transmission via conversations, workshops, and project alignment meetings were mentioned. Thus, the results followed the theoretical line expressed by Lundvall and Johnson (1994).

Regarding the theoretical-analytical perspective of **learning**, this was manifested in different ways. The occurrence of organizational learning was verified through the establishment of operational rules and norms. Likewise, the presence of technological learning was verified, expressed in the tacit knowledge of individuals, transformed into physical systems – prototypes. Other forms of learning were also observed, such as learning by doing, established on the form of knowledge based on the experience of researchers and operators in the exercise of their daily activities. Learning by searching was also present, arising from innovation projects signed between the research and development areas of institutes and companies, demonstrating knowledge sharing, which results in products – prototypes – delivered to the demanding companies. Likewise, the learning by interacting mechanism was identified, resulting from the interactive relationship between institutes and companies, in which cooperation, trust, and mutual responsibility enabled the delivery of products and technical reports. Thus, it made possible to verify the presence of various forms of learning, which is in line with the writings by Argote and Spektor (2011), Malerba (1992), and Figueiredo (2004).

**Routines** were often mentioned by the ISIs as part of the innovation development process. For the representatives of the institutes, some internal processes at SENAI are being optimized, even though there are difficulties in speeding up development, from the beginning of conversations to the delivery of the final product. Routines in relation to contracts were highlighted; these are instruments of paramount importance for the occurrence of interactions, given that they have regulations that must be obeyed by the parties – value, temporality, confidentiality, etc. Likewise, aspects related to changes that occur throughout the product development were mentioned, with some taking two to three years to complete, requiring adaptation and, consequently, changes in established routines and creating new routines. These considerations find correspondence in the theoretical-analytical writings from Nelson and Winter (2005) and Milagres (2011).

In terms of the undertaken project results, the occurrence of incremental technical changes was reported. Even though there are different business considerations regarding the stage in which the use of each innovation was found, the results combined the occurrence of gains with increased productivity and cost reduction, as well as a positive expectation in obtaining economic benefits when the effective use of the new generated product takes place. Given this evidence, the present study demonstrated the importance of institutional arrangements within the innovation system scope aimed at carrying out cooperative projects, whose results contribute to economic development, as stated by Lundvall (2010), Pereira and Dathen (2012), and Mazzucato (2014).

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