Revista Gestão Universitária na América Latina - GUAL | www.gual.ufsc.br ISSN 1983-4535

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

THE GRADUATE PROGRAMS OF ACADEMIC EXCELLENCE OF THE TECHNOLOGICAL CENTER OF THE FEDERAL UNIVERSITY OF SANTA CATARINA AND ECONOMIC DEVELOPMENT

OS PROGRAMAS DE PÓS-GRADUAÇÃO DE EXCELÊNCIA ACADÊMICA DO CENTRO TECNOLÓGICO DA UNIVERSIDADE FEDERAL DE SANTA CATARINA E O DESENVOLVIMENTO ECONÔMICO

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Recebido em 09/agosto/2025
Aprovado em 31/março/2026
Publicado em 01/julho/2026

Sistema de Avaliação: *Double Blind Review*

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

ABSTRACT

This study aimed to investigate the contribution of the Graduate Programs (PPGs) of the Technological Center (CTC) of the Federal University of Santa Catarina (UFSC), internationally recognized by CAPES (Coordination for the Improvement of Higher Education Personnel), which participate in projects awarded by the Stemmer Foundation for Research, Development, and Innovation (FEESC) and the Foundation for Research Support and University Extension (FAPEU), to economic development. This descriptive, applied, and qualitative study collected primary data from ongoing projects awarded by FEESC and FAPEU, specifically those coordinated by faculty accredited in the CTC's PPGs. The objective of this study was to investigate only the Proex programs, that is, those internationally recognized by CAPES. The programs maintain partnerships with national and international organizations. Regarding foreign organizations, 22 projects were identified (9 by FEESC and 1 by FAPEU), totaling R$43,493,803.80 in financial support, with the participation of 240 national researchers (97.96%) and 5 foreign researchers (2.04%). Although the results demonstrate an incipient scenario in the international cooperation process, efforts by the PPGs to encourage the participation of foreign researchers were noted.

Keywords: Internationalization of Higher Education. Proex Programs. Economic Development. FEESC. FAPEU.

RESUMO

Este trabalho teve como objetivo investigar a contribuição dos Programas de Pós-Graduação (PPGs) do Centro Tecnológico (CTC) da Universidade Federal de Santa Catarina (UFSC) reconhecidos internacionalmente pela CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), que participam dos projetos celebrados pela Fundação Stemmer para Pesquisa, Desenvolvimento e Inovação (FEESC) e pela Fundação de Amparo à Pesquisa e Extensão Universitária (FAPEU) para o desenvolvimento econômico. Caracterizada como uma pesquisa de objetivo descritivo, natureza aplicada e abordagem qualitativa, os dados primários foram coletados por intermédio das informações dos projetos vigentes celebrados pela FEESC e FAPEU, especificamente, aqueles coordenados por docentes credenciados nos PPGs do CTC, uma vez que o objetivo envolveu tão somente os programas Proex, isto é, aqueles com reconhecimento internacional pela CAPES. Pode-se constatar que os programas mantêm parcerias com organizações nacionais e estrangeiras. Quanto às organizações estrangeiras, foram identificados 22 projetos (9 pela FEESC e 1 pela FAPEU) que totalizam R$ 43.493.803,80 de aporte financeiro com a participação de 240 pesquisadores nacionais (97,96%) e 5 estrangeiros (2,04%). Muito embora os resultados demonstram um cenário incipiente no processo de cooperação internacional, constatou-se o esforço dos PPGs para fomentar a participação de pesquisadores estrangeiros.

Palavras-Chave: Internacionalização do Ensino Superior. Programas Proex. Desenvolvimento Econômico. FEESC. FAPEU.

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1 INTRODUTION

Globalization has heightened the international significance of nation-states by creating a competitive landscape in which they pursue satisfactory economic growth rates and capital accumulation (Bresser-Pereira, 2009). This growth necessarily involves various organizations engaged in specific activities that together constitute a national innovation system (NIS). First developed in the 1980s, an NIS is represented by "laws, coordination mechanisms, institutions, governments, market-based selection mechanisms, and a financial system that supports innovative investment, among others" (Azevedo, 2016, p. 53).

The NIS also involves economic interaction between companies and universities through the creation of shared knowledge. This transformation is achieved through technological, organizational, and institutional innovations, aiming to enhance favorable development conditions in a coordinated manner (Pereira & Dathein, 2012). In addition to the NIS, the neo-Schumpeterian school considers regional and local environments essential to national economic development. These environments constitute the Regional Innovation System (RIS) (Cário et al., n.d.). Within the RIS, it is understood that the scientific knowledge generated by universities drives technological advancement in companies, facilitating innovation and making university-industry interactions relevant to the country in which they occur (Lemos, 2013).

In this economic development scenario, the Organization for Economic Co-operation and Development (OECD) is an international organization that, in collaboration with governments, policymakers, and citizens, sets standards and practices to improve countries' economic development. To this end, the OECD operates in various areas, including science and technology, corporate governance, education, and lifelong learning (OECD, 2023).

Considering education to be one of the pillars proposed by the OECD, higher education institutions (HEIs) contribute to economic development. HEIs have grown exponentially in size, complexity, and geographical reach (Altbach & Knight, 2007). Consequently, Brazil has increasingly aligned itself with the OECD to promote sustainable economic growth within its territory while addressing issues related to social inclusion and environmental preservation (Brazil, 2023a).

In this regard, the Brazilian federal government invests in training academic researchers to meet market demands and position the country's higher education system on the global stage (Neves & Barbosa, 2020). The Coordination for the Improvement of Higher

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

Education Personnel (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - CAPES), a foundation linked to the Ministry of Education (MEC), was created in 1951 to expand and consolidate stricto sensu graduate programs (master's and doctoral programs) and promote the training of qualified personnel in Brazil and abroad (CAPES, 2023a).

To this end, CAPES evaluates Graduate Programs (PPGs) and assigns grades, classifying them as Graduate Support Programs (PROAP—grades 3 to 5) or Academic Excellence Programs (Programas de Excelência Acadêmica - PROEX—grades 6 and 7). These programs gain international recognition (Maccari et al., 2009; Stallivieri, Snoeijer, & Melo, 2023). The Universidade Federal de Santa Catarina (UFSC) is among the higher education institutions (HEIs) ranked in global rankings that have PPGs designated as PROEX. In its most recent Institutional Development Plan (Plano de Desenvolvimento Institucional - PDI) for the 2020–2024 period, UFSC emphasizes institutional internationalization, a value present in both its institutional identity and one of its academic areas of focus (UFSC, 2019). Based on the results of CAPES's latest quadrennial evaluation of UFSC's graduate programs (2017–2020), the programs of the Technology Center (CTC) that are internationally recognized—and therefore designated as PROEX—were identified.

Regarding its contributions to society and regional and national economic development, the Universidade Federal de Santa Catarina (UFSC) relies on the Stemmer Foundation for Research, Development, and Innovation (FEESC), which was established in 1966 and accredited by a joint decree of the Ministries of Education and Science, Technology, and Innovation. FEESC facilitates coordination between university projects and national and international organizations (FEESC, 2023a). The FEESC enters into contracts and agreements with public and private institutions to promote scientific, technological, economic, and social development through research, teaching, and knowledge transfer. Currently, FEESC is overseeing projects totaling over 1 billion reais (R$1,133,799,719.72). This figure demonstrates the significant contribution of UFSC's graduate programs, particularly the CTC, to advancing scientific research (FEESC, 2023b).

Another organization working with UFSC is the Foundation for Research and University Extension Support (FAPEU).

Established in 1976 by the University Council (CUn) of UFSC, FAPEU is a private, nonprofit legal entity that raises funds to support the university's three pillars: teaching, research, and extension (FAPEU, 2023a). FAPEU's objectives include supporting, securing

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funding for, managing, and executing projects related to teaching, research, extension, innovation, and institutional, cultural, scientific, and technological development that interest UFSC (FAPEU, 2023b). In 2022, FAPEU managed 483 projects totaling R$73,396,134.93 from various sources, including federal, state, and municipal agencies; international organizations; and private companies (FAPEU, 2022).

Given that FEESC and FAPEU projects involve UFSC graduate programs, including CTC programs that received high scores in this evaluation (6 and 7, or Proex), the following research question arises: How do internationally recognized CTC/UFSC graduate programs promote regional economic development when participating in FEESC and FAPEU projects? The objective of this study is to investigate how CTC/UFSC's internationally recognized graduate programs contribute to economic development through their participation in FEESC- and FAPEU-funded projects.

Understanding UFSC's current contributions to society and regional economic development is important. Understanding the participation of the CTC's PROEX graduate programs in projects funded by these two foundations is crucial for establishing the region as a hub for science and technology, particularly given the substantial financial resources involved. This research provides the programs under investigation, other existing graduate programs, the Office of the Dean of Graduate Studies, and UFSC administrators with insight into how participation in projects funded by national and foreign organizations reflects compliance with CAPES, a government evaluation agency, as well as the performance of the graduate programs in relation to society.

2 THEORETICAL BACKGROUND

2.1 THE NATIONAL INNOVATION SYSTEM (NIS) AND REGIONAL INNOVATION SYSTEM (RIS)

The National Innovation System (NIS) is a network of interconnected organizations. Its core consists of institutions that create, disseminate, and adapt new technological information. These institutions may be universities, companies, or government agencies. These institutions are linked by processes, knowledge, resources, people (who possess tacit knowledge and experience), and regulations (Niosi, 2002). The main objective of an innovation system is to identify inventive processes, i.e., to create, disseminate, and utilize innovations. The factors that influence this search for new processes are described as the

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

system's activities (Azevedo, 2016). According to the author, the university-business relationship can include internal sources, such as research and development (R&D) departments, found in companies that prioritize innovation. External sources of innovation include a company's relationships with its customers and suppliers. In more mature industries, they also include scientific information generated in the laboratories of research institutions and universities.

Three constituent elements of the NIS should be highlighted: universities, companies, and research institutes. The State's role is also important. It promotes and coordinates long-term development policies, ranging from macroeconomic regulation and education to investments in R&D and other less tangible areas, such as strengthening social capital and changing behavior. The state also acts as an intermediary and facilitator in stakeholder interactions and fosters regional innovation programs, as Santos (2014) demonstrated. In addition to the NIS, there is the Regional Innovation System (RIS), which the neo-Schumpeterian school considers relevant to the innovation system (Cário et al., 2000-). The SRI differs from the SNI in that the former operates within a specific territory where regional characteristics represent fundamental conditions in the innovation process.

Thus, the SRI is an arrangement of legal entities (companies, institutions, organizations, and networks) that define a region's innovative capacity, becoming "the locus of innovative processes" (Cário et al., 200-, p. 8). Furthermore, establishing an SRI necessarily requires taking into account the region's historical process, which is naturally marked by productive specialization, infrastructure, and institutional configurations (Cário et al., 200-, p. 10).

In this scenario, higher education institutions (HEIs), through their three-pronged foundation of teaching, research, and extension, have become hubs of knowledge and training for the labor market, as well as centers for developing technology and innovation. Thus, higher education has turned to internationalization as a means of fostering institutional quality and relevance. This process emphasizes the constituents of higher education, such as students and faculty, and is supported by advances in information technology (Morosini, 2017). The goal is to attract the business sector, among others. The following subsection will address the internationalization of HEIs.

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

2.2 INTERNATIONALIZATION OF HIGHER EDUCATION INSTITUTIONS

The internationalization of higher education is a response to globalization. A competitive landscape has emerged among institutions of higher education, especially those featured in global rankings (Veiga, 2012). From an economic development perspective, internationalizing higher education can benefit countries by sustaining and promoting scientific advancement through dynamic academic exchanges and building their capacity for social and economic development (Jibeen, Khan, & Asad, 2015).

Knight (2004) identifies five motivations for HEIs to become internationalized: political (to promote peace, regional and national identity formation, and mutual understanding); economic (to promote economic development and increase competitiveness in the international market); sociocultural (to foster citizenship, a sense of community, national cultural identity, and intercultural awareness); academic (to broaden academic horizons, impacting the development of the HEI); and market-oriented (to seek status and reputation on the international stage). Maués (2019, p. 22) states that "about internationalization, the goal is to establish a network of educational institutions, faculty, students, and other stakeholders, such as companies."

Internationalization is the process of transcending borders through the involvement of various stakeholders, such as governments, institutions, public and private sectors, companies, shareholders, faculty, staff, students, researchers, and local communities (Stallivieri & Vianna, 2020). In Brazil, the federal government has the National Graduate Studies Plan (Plano Nacional de Pós-Graduação - PNPG), which, as early as the launch of the PNPG 2005–2010 in 2004, highlighted the importance of the country’s integration into the international arena and its impact on economic development (Brazil, 2004).

The subsequent PNPG for 2011–2020 placed greater focus on internationalization, emphasizing several relevant issues: international cooperation, funding agencies, the participation of the National Research Council (Conselho Nacional de Pesquisa - CNPq), and the Ministry of Science, Technology, and Innovation's (Ministério da Ciência, Tecnologia e Inovação - MCTI) Agency for the Financing of Studies and Projects (Financiadora de Estudos e Projetos - FINEP), and collaboration between national and international institutions and companies (Brazil, 2010). Regarding stricto sensu graduate programs (master's and doctoral programs), internationalization is one of the subcriteria evaluated by CAPES, a foundation affiliated with the Ministry of Education (MEC) (CAPES, 2023a).

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

In the most recent quadrennial evaluation (2017–2020), CAPES assessed graduate programs based on three criteria: Program, Training, and Impact on Society. Internationalization appeared as a sub-criterion within the Impact on Society category (sub-criterion 3.3: Internationalization, Integration (Local, Regional, and National), and Program Visibility" (CAPES, 2021).

The CAPES evaluation system reviews applications for new programs (Evaluation of Proposals for New Courses, or APCNs) and the continued accreditation of existing graduate programs (Periodic Evaluation). Programs are evaluated on a scale of 1 to 7. Programs with courses receiving grades of 1 or 2 are not accredited. Those already accredited who subsequently receive these grades are decertified. Programs with courses receiving grades between 3 and 5 are accredited and designated as Graduate Studies Support Programs (PROAP). Programs with courses receiving grades of 6 or 7 are accredited and designated as Academic Excellence Programs (PROEX). These programs gain international recognition (Maccari et al., 2009). Financial resources are needed to promote graduate studies by establishing and improving physical infrastructure (laboratories) and hiring researchers (through scholarships) to develop research projects. The next subsection will address sources of funding allocated to Brazilian higher education.

2.3 SOURCES OF FUNDING FOR HIGHER EDUCATION INSTITUTIONS IN BRAZIL

In Brazil, the state must provide financial resources to ensure the basic functioning of education and research. However, funding sources for Brazilian higher education institutions were heavily influenced by World Bank policies in the 1990s. During that period, Brazilian governments under Presidents Fernando Henrique Cardoso (1995–2003) and Luiz Inácio Lula da Silva (2003–2010) based their higher education policies on two pillars: diversifying higher education institutions (HEIs) and diversifying funding sources (Lima, 2011).

According to Tumenas (2021, p. 280), "Public funding plays a central role in research at universities that are well-positioned in international rankings, whether through research grants or through laboratories directly maintained by governments." In the face of crises stemming from the Brazilian political and economic landscape and cuts to public funding for higher education, however, the search for alternative funding sources—not derived from public coffers—became necessary to support scientific research and promote graduate studies in the country. In a study of a Brazilian federal higher education institution's funding sources,

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

Kauling et al. (2011) concluded that funds came from three sources: state funds backed by law, public and private funds through contracts, and funds provided to students through scholarships or expense reimbursements.

One possible form of funding is the contractual model, in which institutions sign contracts with public or private entities to provide services or conduct research. Furthermore, students may receive monthly stipends for this purpose (Amaral, 2003). Funding may come from national or foreign organizations. As noted by Guimarães (2000), foreign companies, particularly multinationals, play a prominent role in funding research. The author further points out that countries like Brazil, considered developing nations, seek safe, short-term investment opportunities because foreign capital expands the funds available for investment in specific high-potential areas.

Costa, Porto, and Feldhaus (2010, p. 102) state that "the growth of cooperative agreements between research institutions and business entities thus represents a new trend driven by society." Furthermore, these new sources of funding "are considered survival strategies in light of the problematic financial situation faced by such institutions" (Fávero & Bechi, 2017, p. 93).

After presenting the theoretical framework, the next section outlines the methodological procedures for this study.

3 METHODOLOGICAL PROCEDURES

This descriptive study aims to characterize a phenomenon or population (Silva & Menezes, 2005). It employs a qualitative approach to conduct an in-depth comparative analysis based on obtained data (Markoni & Lakatos, 2010).

This study examines projects managed by FEESC and FAPEU, with coordinators participating in internationally recognized, CAPES-approved CTC programs, and seeks to describe the relationship between these programs and economic development.

Secondary data were collected through a literature review to provide an overview of the main theorists addressing the topic under investigation. The scientific databases Google Scholar and Web of Science were searched using the keywords "National Innovation System," "Regional Innovation System," "Global Economic Development," "Internationalization of Higher Education Institutions," "Graduate Program Evaluation,"

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

"Foreign Capital in Research," "Funding Sources for Higher Education Institutions," and "University Funding."

Additionally, information was collected on active projects from UFSC-affiliated foundations (FEESC and FAPEU). This information was obtained from the foundations' websites, which constituted the sample population. From this population, we listed those coordinated by faculty members accredited in the CTC's graduate programs (PPGs) with CAPES evaluation scores of 6 and 7, since our objective involved only the Proex programs—that is, those evaluated by CAPES as internationalized programs in the Foundation's most recent quadrennial evaluation (2017–2020).

We sought to conduct an in-depth analysis of foreign organizations acting as funders, given that their headquarters are in another country, and to examine the trends and relevance of foreign financial contributions to scientific research, as noted by Guimarães (2000) and Costa, Porto, and Feldhaus (2010). Thus, we investigated foreign organizations on the FEESC and FAPEU platforms and, among these organizations, the respective coordinators and researchers participating in the selected projects. The analysis also considered foreign researchers affiliated with foreign organizations who participate in these projects, given the relevance of graduate programs in the landscape of international cooperation, as addressed by Feijó (2019), Paiva and Brito (2019), and Oliveira Cabral et al. (2020).

Please note that the information on these foundations' websites only lists the name of each project's coordinator and does not specify the names of the other participating researchers. To obtain the names and numbers of researchers for each project and to verify the participation of foreign researchers, the Integrated Management System for Research and Extension Projects (SIGPEX) website was consulted. SIGPEX is linked to the Office of the Dean of Research and Extension (Proex) at UFSC (SIGPEX, 2023). Based on SIGPEX's information, all registered researchers were identified. With this list in hand, the CNPq Lattes platform was accessed to consult information on each researcher. Additionally, the Google platform was used to corroborate the information in case it was outdated on the Lattes platform or if the researcher was not registered there.

In addition to investigating the Lattes platform, emails were sent to the coordinators of each project that listed a foreign organization as a funder to confirm the participation of foreign researchers. Not all coordinators responded to the verification email, so the accuracy of the information recorded on the SIGPEX platform was accepted. Additionally, the absence

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

of certain project details is notable, given the confidential nature of some projects and guidance from the Office of the Dean of Research and Extension on the nondisclosure of information about them.

The data collection period was September 2023. For data analysis, an interpretive approach was used. According to Triviños (2012), this approach is grounded in three main aspects: the results obtained through the collected data, the theoretical framework used in conjunction with the data, and the researcher's experience. After describing the methodological procedures, the next section presents the results of this investigation.

4 RESULTS AND DISCUSSION

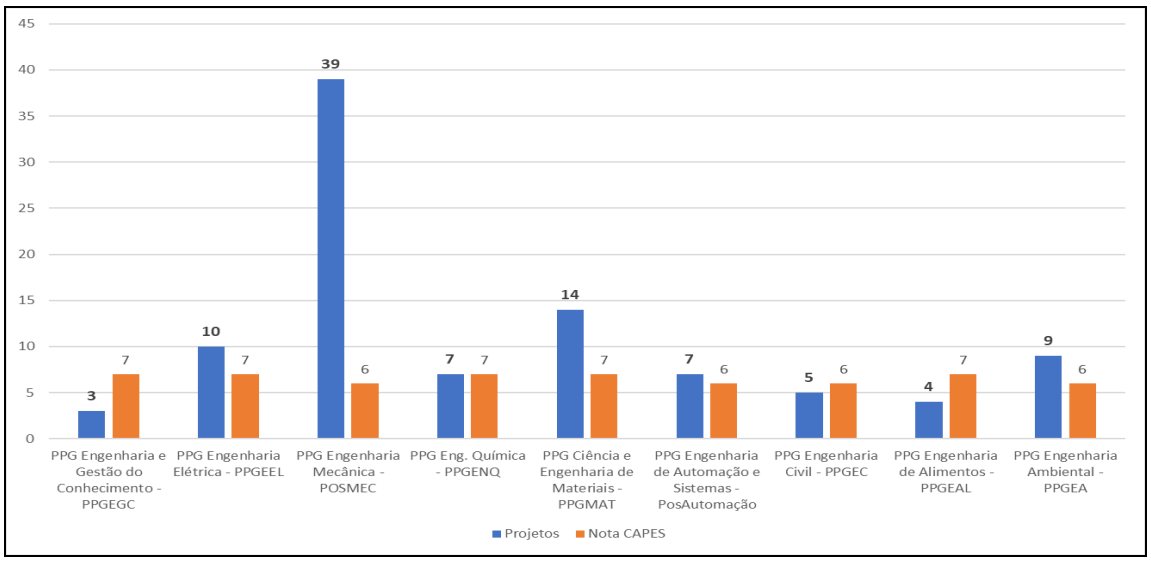
The organizations examined were FEESC and FAPEU, two UFSC-affiliated foundations that facilitate contracts between the university and organizations across a wide range of economic sectors. According to the outlined methodological procedures, the first stage was to survey the projects at these foundations. This resulted in a total of 308 ongoing projects. FAPEU accounted for 42.8% (132) of the total, while FEESC accounted for 57.2% (176).

The next stage involved verifying projects whose coordinators were affiliated with the CTC's PROEX graduate programs. This activity was found to occur in nine CTC programs that achieved the highest scores (6 and 7) in CAPES's latest four-year evaluation (2017–2020): Civil Engineering (PPGCE), Environmental Engineering (PPGEE), Food Engineering (PPGFE), Chemical Engineering (PPGCE), Mechanical Engineering (POSMEC), Production Engineering (PPGPE), Electrical Engineering (PPGELE), Automation and Systems Engineering (PosAutomação), Engineering and Knowledge Management (PPGEKM), and Materials Science and Engineering (PPGMAT).

Of the 176 active projects at FEESC, 98 coordinators met this criterion, totaling approximately 140 million reais (R$142,350,703.77). Notable among these are the Mechanical Engineering (POSMEC, score 6) and Materials Science and Engineering (PPGMAT, score 7) programs, which currently have 39 and 14 projects, respectively, totaling approximately 56 million reais (R$56,349,581.42) in research and extension funding. Figure 1 presents the results.

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

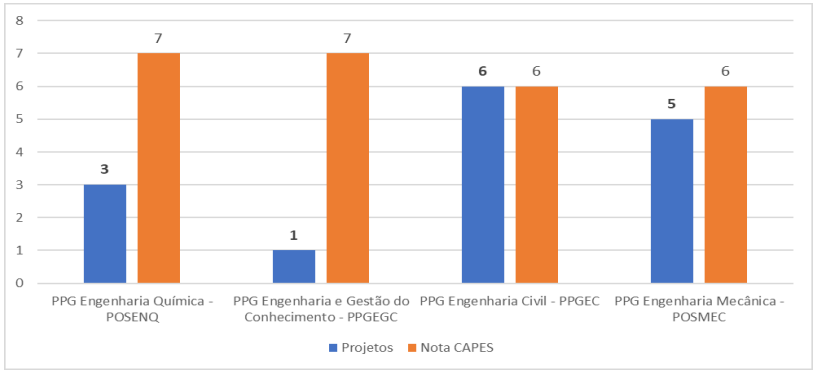
Graph 1 Projects facilitated by FEESC involving the CTC's Proex graduate programs



Source: Prepared by the authors.

Other graduate programs (PPGs) that stand out as project participants include PPGEEL (10), followed by PPGEE (9), PPGCE and PosAutomação (7 each), PPGEGC (5), PPGFE (4), and PPGEKM (3). At FAPEU, which oversees 132 active projects totaling approximately 96 million reais (R$ 96,521,037.81) (FAPEU, 2022), 15 of these involve coordinators working in 4 CTC graduate programs rated 6 and 7. Figure 2 presents these programs and the respective numbers of active projects.

Graph 2 Number of projects facilitated by FAPEU involving the CTC's Proex graduate programs



Source: Data collection.

Initially, it was noted that FEESC-supported projects involve more Proex programs (9) from the CTC and a greater number of projects (53) than FAPEU-facilitated projects (15), which involve only 4 Proex programs. POSMEC stands out among the other programs because, when its participation in FEESC and FAPEU projects is combined, it totals 44

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

projects. Furthermore, the total amount was calculated to be approximately 240 million reais (R$238,871,741.58), resulting from the sum of funds allocated by FEESC (R$142,350,703.77) and FAPEU (R$96,521,037.81). These funds come from national and foreign organizations.

The substantial amount allocated to research and extension highlights the university-industry partnership. Through its graduate programs, UFSC serves as a source of innovative research and development (R&D) fundamental to the industrial sector and economic development, as discussed by Azevedo (2016). Many organizations lack an R&D structure with a team of researchers and developers and thus invest in higher education institutions, such as UFSC, to acquire scientific and technological knowledge and carry out innovation.

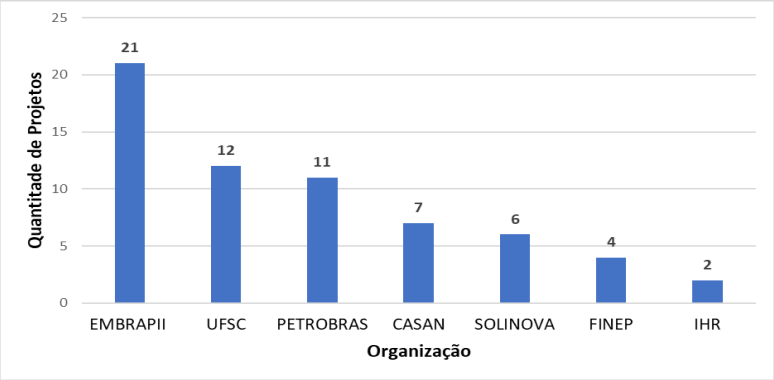
This research indicates that an SRI is also evident in this university-enterprise relationship, as UFSC has been transforming the region through science and technology for several decades, becoming a major technological hub in southern Brazil and mobilizing considerable financial resources for the region's economic development. According to Cario et al. (200-), an SRI is established when there is an arrangement among agents, such as companies, organizations, and UFSC. Lemos (2013) states that the outcomes of this innovative process and knowledge generation across different regions are substantial for a country's development.

A survey was subsequently conducted of the organizations funding the projects at both foundations. Of the 99 participating organizations at FEESC, 81 (82%) are national. Notable examples include the Brazilian Industrial Research and Innovation Company (EMBRAPII), a social organization accredited by the federal government that has supported technological research institutions and fostered innovation in Brazilian industry since 2013 (EMBRAPII, 2023); Petrobras, which develops technology primarily focused on oil extraction in ultra-deep waters (Petrobras, 2023); the Santa Catarina Water and Sanitation Company (CASAN), which operates in municipalities through program contracts to manage and maintain water supply, sewage collection, and wastewater treatment systems (CASAN, 2023); Solinova, a company that develops projects encompassing energy efficiency techniques, alternative renewable energy sources, and other energy-related services (Solinova, 2023); and the Brazilian Innovation Agency (FINEP). These organizations include FINEP (a public entity that promotes technological development, research, and innovation), the Hercílio Randon Institute (IHR, which applies science and technology to the automotive sector, including embedded

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

electronics, mobility, and smart materials), and UFSC (whose mission is to identify, create, and implement innovative and entrepreneurial actions and practices, contributing financial resources and serving as a cradle of scientific and technological knowledge for a wide range of sectors in national and international industries). Figure 3 shows these organizations and their participation in two or more FEESC-facilitated projects.

Graph 3 National funders with the largest share in projects funded by FEESC



Source: Data collection.

Other organizations that fund projects with these graduate programs include WEG. This company specializes in manufacturing and selling electric motors, transformers, generators, and paints (WEG, 2023), as well as Dynamox, an organization that promotes Industry 4.0 solutions (Dynamox, 2023), among others. These companies are not included in the aforementioned chart because they participate in only one project each. This demonstrates that, through these programs and their interrelationships with these organizations, UFSC seeks not only regional economic development, but also to meet national demands (EMBRAPII, Petrobras). Thus, UFSC and the other legal entities set a high standard and form the core of an SNI. According to Niosi (2002) and Pereira and Dathein (2003), collaboration among legal entities (government agencies, companies, and higher education institutions [HEIs]) constitutes a system that leads to the production and dissemination of new knowledge.

FEESC carries out projects with 18 foreign organizations, accounting for 18% of its total projects. Notable organizations include: Whirlpool Corporation, which is headquartered in the U.S. and focuses on developing and innovating technology for home appliances, primarily for kitchens and laundry rooms (Whirlpool, 2023); BYD Energy, which is part of the Chinese company Build Your Dreams (BYD) and has been active since its inception in

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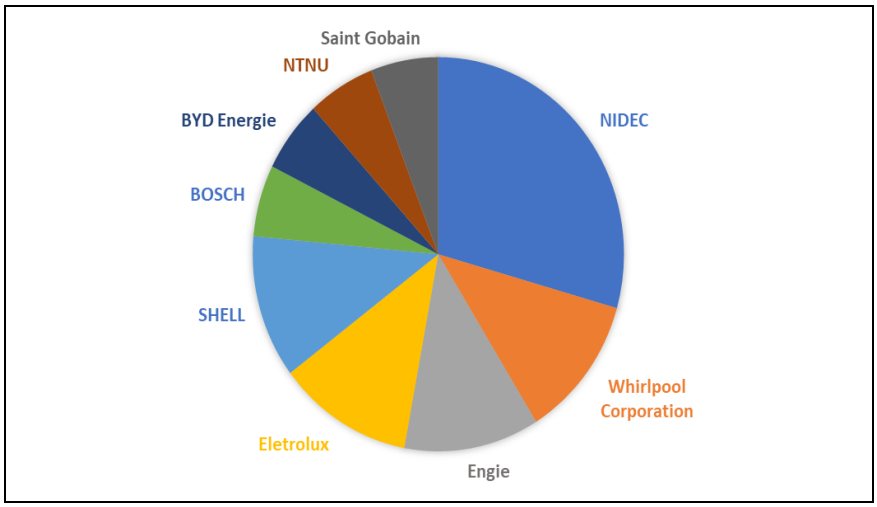
1995 in developing energy generation and storage technologies and electric mobility (BYD, 2023); the Norwegian University of Science and Technology (NTNU), which is a Norwegian higher education institution that seeks strategic international partnerships for scientific and technological development (NTNU, 2023); Saint-Gobain, which is a French company and a global leader in the construction industry, designing and distributing lightweight, sustainable construction and industrial materials and services (Saint-Gobain, 2023); and Engie, which is a French company that is active in renewable energy, from electricity generation to transmission. Engie (2023), Nidec (headquartered in Kyoto, Japan) (Nidec, 2023), Electrolux (Electrolux, 2023), Shell (Shell, 2023), and Bosch (Bosch, 2023) are global leaders in their respective industries. Nidec is a global leader in manufacturing motor parts, with 330 facilities across 34 countries. Electrolux has been active in the home appliance sector since 1919. Shell is a global energy and petrochemical company headquartered in London, United Kingdom, and has been since 1907. Bosch is a German multinational leader in the supply of technology and services. Figure 4 shows these companies' share of project financing.

Graph 4 Participation of foreign organizations in the funding of projects undertaken by FEESC



Source: Data collection.

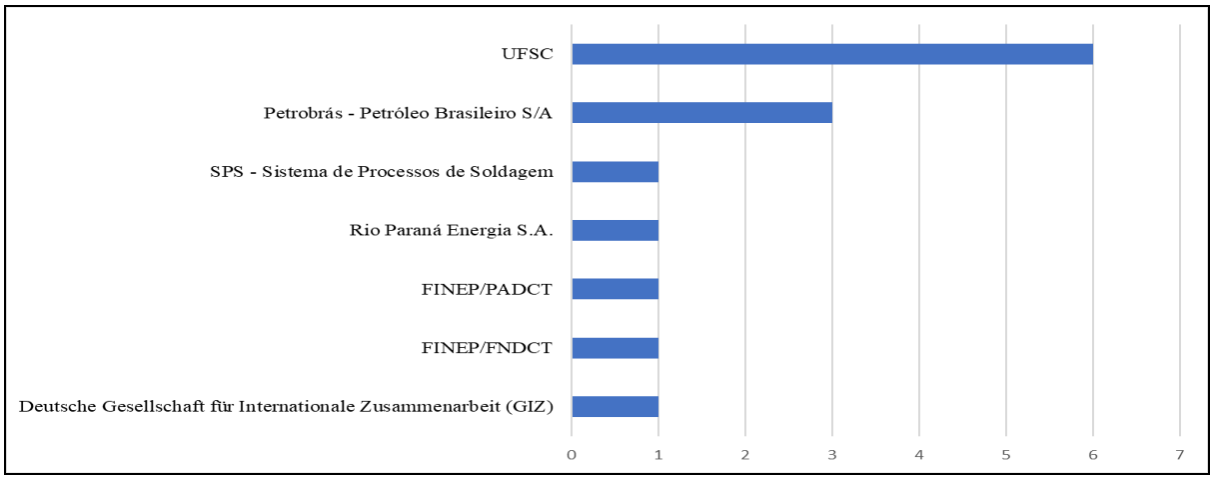
Meanwhile, at FAPEU, it was observed that, of the 14 active projects involving members of the CTC's PROEX programs, 11 focus on research and four focus on extension. It is also notable that PPGEC participated in the majority of projects (5), followed by POSMEC (4), PPGENQ (2), and PPGEGC (1). Thirteen national organizations (92.3%) and one international organization (7.7%) were identified as funding organizations.

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

Among the national organizations, the following stand out: FINEP, through the Program for Support to Scientific and Technological Development (PADCT) and the National Fund for Scientific and Technological Development (FNDCT); Sistema e Processos para Soldagem (SPS), which aims to identify welding problems in Brazilian companies and partners with the UFSC Welding Laboratory (Labsolda); Rio Paraná Energia S.A., which is located in Três Lagoas (MS) and focuses on electricity generation; and Petrobras.

The international organization is the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). This German private company specializes in global technical cooperation projects for sustainable development and is funded by the German government. In Brazil, GIZ focuses on renewable energy, energy efficiency, and the protection and sustainable use of the tropical rainforest. Brazil is a pioneer in Latin America in producing carbon dioxide (CO2)-free energy through large-scale hydroelectric power plants (GIZ, 2023). Figure 5 was created based on this information and presents these organizations and their respective participation in the projects.

Graph 5 Projects awarded by FAPEU and their respective funding sources



Source: Data Collection.

Based on the data obtained from the two foundations, it is evident that the CTC's Proex programs maintain partnerships with domestic and foreign organizations—some of which are multinational — through FAPEU and, primarily, FEESC. The foreign organizations are headquartered in countries across Europe, Asia, and North America.

The next step involved verifying the researchers participating in projects funded by foreign organizations, as described in the methodological procedures. We verified the existence of 22 projects, supported by FEESC and FAPEU, that receive funding from 10

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foreign organizations (9 through FEESC and 1 through FAPEU), totaling R$ 43,493,803.80. Based on this amount, Table 1 presents, for each project, the foreign funding organization, the graduate program involved, and the number of Brazilian and foreign researchers.

Table 1 Number of participants per project funded by foreign organizations

Project	Foreign Organization	Program	Researcher (domestic)	Researcher (foreign)	Foreign country (if any)	Foreign Organization
1	Whirlpool	POSMEC	15	1	Holanda	Delft University of Technology (TU Delft)
2	Whirlpool	POSMEC	18	0	-	-
3	Whirlpool	PPGEAL	8	0	-	-
4	Engie	PPGEEL	12	0	-	-
5	Engie	PPGEEL	2	0	-	-
6	NIDEC	POSMEC	7	0	-	-
7	NIDEC	PosAutomação	8	0	-	-
8	NIDEC	POSMEC	17	0	-	-
9	NIDEC	POSMEC	17	1	Holland	Delft University of Technology (TU Delft)
10	NIDEC	POSMEC	12	1	Spain	Instituto de Cerámica y Vidrio (ICV)
11	Saint Gobain	PPGEC	18	0	-	-
12	GIZ	PPGEC	16	0	-	-
15	SHELL	PPGEC	27	0	-	-
16	SHELL	POSMEC	6	0	-	-
17	BOSCH	PPGMAT	15	0	-	-
19	Eletrolux	POSMEC	22	0	-	-
20	Eletrolux	POSMEC	12	0	-	-
21	BYD Energia	PPGEC	3	0	-	-
22	NTNU	PosAutomação	5	3	Norway	Norwegian University of Science and Technology (NTNU)

Source: Data collection.

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The data reveal that although foreign organizations fund 22 projects involving 245 researchers (including both Brazilians and foreigners), the total number of foreign researchers identified (five researchers, since one researcher from the Netherlands participates in two projects) represents only 2.04% of all researchers involved.

Although the number of foreign researchers is low compared to domestic researchers, this reflects an internationalization process at UFSC as cooperative relationships among researchers develop. According to Maués (2019), internationalization represents a participatory network of actors, including faculty, students, researchers, and companies. This is evident in the study's results. Regarding the participation of graduate programs (PPGs) in foreign-funded projects, POSMEC was found to participate in most projects (8), totaling approximately 12 million reais (R$11,908,268.72). These projects involve thermodynamic and acoustic materials for the home appliance industry, robotics, virtual systems, equipment performance evaluation, and energy efficiency.

Compared with the total amount of domestic and foreign financial contributions to projects supported by the two foundations and involving CTC's Proex Programs (R$ 238,871,741.58), POSMEC receives 4.98% of the total. However, POSMEC's contribution percentage rises from 33.5% to 36.5%, compared with the amount specifically funded by the ten foreign organizations that have contracts with FEESC and FAPEU (R$43,493,803.80). In addition to POSMEC, PPGEC participated in four projects, followed by PPGEEL (two), PosAutomação (two), POSMAT (one), and PPGEAL (one).

Financial contributions from domestic and foreign organizations reflect the Programs' and UFSC's efforts to secure funding, primarily for scientific research. According to Stallivieri and Vianna (2020), UFSC participates in the internationalization process by expanding its boundaries through engagement with various actors, including governments, companies, researchers, and the public and private sectors. Furthermore, the UFSC promotes economic development and integration into the international market while broadening academic horizons (Knight, 2004).

Participation in the investigated projects benefits the Proex programs under review in terms of institutional internationalization and graduate programs, as it meets the specific CAPES evaluation criterion on program internationalization (criterion 3—Impact on Society, subcriterion 3.3). Internationalization, integration—local, regional, national—and program visibility, with emphasis on: i. fundraising (domestic and foreign) for the development of

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

research and extension projects, which should involve companies in contracting services and purchasing equipment; ii. meeting business demands involving technological innovations across a wide range of sectors, leading to regional, national, and international development through multinational corporations; iii. attracting students and researchers (master's, doctoral, and postdoctoral candidates) through the provision of scholarships, which boosts various sectors of the local economy (lodging, food, culture, leisure); iv. institutional visibility and visibility of the programs involved in the projects to scientific research funding agencies (national and international); and v. maintaining and/or improving the score achieved in the most recent quadrennial evaluation of the CTC's PROEX graduate programs through the projects funded by the foundations under investigation.

In contrast, multinational organizations, which are typically headquartered in developed countries, seek to attract specialized personnel through research funding in developing countries such as Brazil. This process, known as "brain drain," yields substantial gains for the country of origin through internationalization, as stated by Jibeen, Khan, and Asad (2015). Furthermore, outsourcing research through funding, rather than establishing specific R&D sectors, is in the interest of multinational companies. Thus, reduced costs and the creation of innovative products make profits attractive and lucrative, as noted by Guimarães (2000).

5 FINAL CONSIDERATIONS

This study investigated the contribution of internationally recognized graduate programs at CTC/UFSC to economic development. These programs participate in projects funded by FEESC and FAPEU. The results demonstrate that these programs significantly contribute to economic development, especially through their involvement in POSMEC (44), POSMAT (14), POSENQ (10), PPGEEL (10), and PosAutomação (7) projects. Additionally, a significant amount of financial resources from national and international organizations was found in the projects undertaken by FEESC and FAPEU.

Furthermore, data on foreign funding organizations showed low participation by foreign researchers (only 5) compared with Brazilian researchers (245). While the results demonstrate the early stages of international cooperation, the graduate programs' efforts to encourage the participation of foreign researchers, funded by foreign organizations secured by the two foundations, were evident.

DOI: https://doi.org/10.5007/1983-4535.2026.e108311

This study specifically investigated foreign researchers in projects funded by foreign organizations. Future research should expand this scope to include projects funded by domestic companies to verify whether the results differ from those of this study. Furthermore, given the financial contributions from national and foreign organizations, UFSC is recognized as a potential higher education institution that drives societal progress and contributes to regional and even national economic development, against the backdrop of cuts in public funding for scientific research in the country.

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