

Innovation in Public Health With Social Impact: lessons learned in a non-university state public ICT

Inovação em Saúde Pública com Impacto Social: lições aprendidas em uma ICT pública estadual não universitária

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Abstract

This article identifies and highlights the institutional and operational factors that contributed to the delivery of technological solutions, professional qualification strategies and evidence applied to public health in Espírito Santo, based on cooperation experiences led by the Capixaba Institute for Education, Research and Innovation in Health (ICEPi). This is a case study with a qualitative approach, based on documentary analysis of three projects: Viana Vacinada, ProticSUS and Qualifica-APS. The analysis was guided by a matrix of analytical categories organized into two dimensions: institutional and operational factors. This organization allowed us to assess everything from the strategic alignment and transformative capacity of the ICT to the aspects of execution, impact and legal certainty of the partnerships. The results allow us to understand how innovation materializes in practice through interinstitutional arrangements that articulate applied research, public management and care for the population. The experience in Espírito Santo reinforces the role of the State as a strategic commissioner of solutions for the SUS, based on an ICT in health with structured action by its NIT.

Keywords: Innovation in Health; Collaboration in Health Research; Center for Technological Innovation.

Technological Area: Technological Innovation Management.

Resumo

Este artigo identifica e evidencia os fatores institucionais e operacionais que contribuíram para a entrega de soluções tecnológicas, estratégias de qualificação profissional e evidências aplicadas à saúde pública no Espírito Santo, a partir de experiências de cooperação lideradas pelo Instituto Capixaba de Ensino, Pesquisa e Inovação em Saúde (ICEPi). Trata-se de um estudo de caso com abordagem qualitativa, fundamentado em análise documental de três projetos: Viana Vacinada, ProticSUS e Qualifica-APS. A análise foi guiada por uma matriz de categorias analíticas organizadas em duas dimensões: fatores institucionais e fatores operacionais. Essa organização permitiu avaliar desde o alinhamento estratégico e a capacidade transformadora da ICT até os aspectos de execução, impacto e segurança jurídica das parcerias. Os resultados permitem compreender como a inovação se materializa na prática por meio de arranjos interinstitucionais que articulam pesquisa aplicada, gestão pública e cuidado à população. A experiência capixaba reforça o papel do Estado como encomendante estratégico de soluções para o SUS, a partir de uma ICT em saúde com atuação estruturada de seu NIT.

Palavras-chave: Inovação em Saúde; Colaboração em Pesquisa em Saúde; Núcleo de Inovação Tecnológica.



1 Introduction

The production of knowledge and innovation with social impact remains a persistent challenge for Brazilian public institutions, particularly in the field of health. Within the scope of Brazil's Unified Health System (SUS), the creation of institutional models capable of articulating different stakeholders, including universities, managers, healthcare workers, communities, and municipalities, has become central to strengthening the State's capacity to address complex problems.

Science, Technology, and Innovation (ST&I) play a pivotal role in the development of more efficient, equitable, and sustainable health systems. In Brazil, the consolidation of a National Policy for Science, Technology, and Innovation in Health (PNCTI/S) reflects the need to align scientific efforts with the demands of the healthcare system and the population. ST&I in health drives knowledge production and guides the development of technological solutions capable of responding to emerging public health challenges. Guimarães *et al.* (2019) regard the current PNCTI/S as a fundamental instrument for strengthening the Unified Health System (SUS) and advancing public health in Brazil. The authors highlight three main pillars: the SUS, the productive base of health goods and services, and the installed capacity for ST&I. This framework is essential for building a sustainable development agenda in health.

The Espírito Santo Institute for Teaching, Research, and Innovation in Health (ICEPi), established in 2019 in the state of Espírito Santo, represents one such organizational innovation. ICEPi is a Scientific, Technological, and Innovation Institution (STII), established under Federal Law No. 10,973/2004, with the mission of developing educational, research, and innovation policies and initiatives aimed at generating and disseminating scientific knowledge in the field of health. Its creation is aligned with Article 200 of the Brazilian Federal Constitution, which assigns to the SUS the responsibility for managing the training of health professionals and fostering scientific, technological, and innovation development (Brazil, 1988).

According to a survey conducted by the National Council of State Health Secretaries (CONASS, 2020), Espírito Santo is the only Brazilian state to have established an organization with the status of a Scientific, Technological, and Innovation Institution dedicated exclusively to health, rather than limiting itself to the creation of a School of Public Health or a Government School. As a result, the state stands out as a pioneer in establishing a state-level health STII focused on innovation and the strengthening of the SUS.

Article 16 of Federal Law No. 10,973/2004 stipulates that “public STIIs shall maintain a Technological

Innovation Center” (Brazil, 2004). Accordingly, ICEPi established its Technological Innovation Center (NIT) on February 19, 2021, through ICEPi Ordinance No. 003-R. Since its creation, ICEPi, through its NIT, has entered into several technical cooperation agreements with federal, state, and municipal institutions aimed at developing solutions applicable to public health management, health education, and population care. More than merely formal instruments, these agreements function as mechanisms for coordination, co-production, and implementation of public policies. Through these partnerships, ICEPi seeks to transform technical and scientific knowledge into tangible benefits for society, including digital technologies, scientific evidence, and strategies to strengthen primary healthcare.

Nevertheless, given the challenges faced by STIIs and NITs in Brazil, such as resource constraints, limited integration with the productive sector, the absence of structured internal processes, and shortcomings in strategic management, it is necessary to discuss and identify best practices capable of addressing these weaknesses. In this regard, the specialized literature emphasizes the importance of objective criteria for evaluating the effectiveness of interinstitutional partnerships that foster innovation, particularly those aimed at delivering tangible solutions to society (Paranhos & Ribeiro, 2018; Reina, Tomaz, & Magalhães, 2021; Alcântara, Borschiver, & Alencar, 2021; Carvalho & Renault, 2019; Freitas & Lago, 2019; Paiva *et al.*, 2023; Pires & Silva, 2023; Machado *et al.*, 2023; Carneiro *et al.*, 2022).

Inspired by approaches that view the State as a driver of innovation (Mazzucato, 2014) and by concepts of collaborative governance in public policy (Emerson & Nabatchi, 2015), this article aims to identify and highlight the lessons learned by ICEPi throughout the development and implementation of partnership agreements, based on the analysis of three projects and programs: Qualifica-APS, ProticSUS, and Viana Vacinada. The objective is to understand how cooperation among public institutions can generate concrete impacts within the SUS when guided by a strategic vision and flexible governance arrangements, emphasizing the factors that facilitated or hindered innovation and the delivery of results by the STII, including the role played by its NIT.

The analysis was guided by analytical categories derived from the literature specifically reviewed for this study, organized as follows: (i) strategic objectives; (ii) diversity and complementarity of partners; (iii) tangible products and deliverables resulting from the partnerships; (iv) agreement format and partnership type; (v) integration of teaching, research, extension, and management activities; (vi) attraction and mobilization of external resources; (vii) application of the STII/NIT's internal capabilities; (viii) degree of replicability; and (ix) institutional learning

derived from both the experience itself and the challenges encountered. The study adopted a case study approach, based on documentary analysis of agreements, reports, scientific publications, news reports, and institutional materials from the State Health Secretariat and ICEPi. One of the authors, as a collaborator within the institution, also drew upon internal institutional documents not publicly available, while observing all ethical and methodological boundaries, as well as relevant professional experiences and contextual aspects deemed important for reporting. Through this approach, the study seeks to contribute to the debate on innovation in the public sector, particularly in health, by providing theoretical and practical insights for managers, researchers, and public policy makers.

2 Methodology

This study adopts a case study approach focused on the role of the Espírito Santo Institute for Teaching, Research, and Innovation in Health (ICEPi), including its Technological Innovation Center (NIT), in the formalization and implementation of interinstitutional cooperation agreements that generated products and services delivered to the population of Espírito Santo. The selection of ICEPi as the case under investigation is justified by its strategic role in strengthening Brazil's Unified Health System (SUS) in the state of Espírito Santo, particularly through the integration of science, management, and healthcare delivery by means of projects that produced tangible outcomes.

The empirical scope of the study comprises three projects and programs developed between 2020 and 2025: Viana Vacinada, ProticSUS, and Qualifica-APS. These cases were selected because they represent relevant experiences of technical cooperation that resulted in applied products, including digital platforms, scientific evidence, and strategies for the reorganization of primary healthcare services. The primary selection criterion was the existence of documented public deliverables directly resulting from formally established cooperation agreements.

Data collection was conducted through the analysis of institutional documents, including work plans, technical reports, ordinances, cooperation agreements, and public communication materials available on the websites of the State Health Secretariat (SESA) and ICEPi. The study also incorporated findings reported in local newspapers, scientific journals, and technical dissemination publications that documented project outcomes. In addition to publicly available sources, this research benefited from access to internal ICEPi documents made possible through the institutional affiliation of one of the authors as a researcher within the organization. This access enabled

the examination of non-public aspects of the negotiation, design, and implementation processes associated with the agreements, while fully respecting the ethical principles of qualitative research and institutional confidentiality. The incorporation of this insider perspective was intended to enrich the analysis without compromising the objectivity of the findings.

Data collection and analysis activities were guided by analytical categories derived from the literature specifically reviewed for this study. To support data interpretation, thematic content analysis (Bardin, 2016) was employed, focusing on the identification of recurring patterns within the analyzed documents and the systematic organization of evidence according to previously defined analytical categories. These categories were developed through a critical review of the challenges and recommendations identified in the literature concerning the performance of Technological Innovation Centers (NITs) in Brazil.

Drawing upon the studies of Paranhos and Ribeiro (2018), Reina, Thomaz, and Magalhães (2021), Alcântara, Borschiver, and Alencar (2021), Carvalho and Renault (2019), Freitas and Lago (2019), Paiva *et al.* (2023), Pires and Silva (2023), Machado *et al.* (2023), and Carneiro *et al.* (2022), the analytical categories were organized into two dimensions: institutional factors and operational factors. This classification, presented in Box 1, was used both to guide data collection and analysis and to structure the discussion of results. The analytical process consisted of triangulating documentary evidence, theoretical literature, and the objectives of the selected projects in order to understand how the different factors manifested in each case and what forms of institutional learning emerged from these experiences. This approach enabled a structured assessment of the cooperation agreements under analysis, linking empirical findings to theoretical discussions on public sector innovation, interinstitutional governance, and the role of NITs, while supporting the identification of the key elements that contributed to the generation of tangible benefits for society.

3 Results and Discussion

This section presents the results obtained from the documentary analysis and case study of the selected experiences. The discussion is grounded in the integration of the collected data with the theoretical framework, seeking to demonstrate how the institutional and operational factors of the Espírito Santo Institute for Teaching, Research, and Innovation in Health (ICEPi) enabled the delivery of technological solutions and capacity-building strategies within the scope of Brazil's Unified Health System (SUS).

Box 1 – Analytical categories adopted

FACTOR	ANALYTICAL CATEGORY	RATIONALE	SOURCE
Institutional	Clear objectives aligned with the mission of the STII/NIT	Strengthens strategic focus	(Carneiro <i>et al.</i> , 2022; Machado <i>et al.</i> , 2023)
	Diversity and complementarity of partners	Expands innovation capacity	(Alcântara; Borschiver; Alencar, 2021; Reina; Thomaz; Magalhães, 2021)
	Integration of teaching, research, extension, and management activities	Enhances transformative capacity	(Alcântara; Borschiver; Alencar, 2021; Paranhos e Ribeiro, 2018)
	Application of the NIT's internal capabilities	Strengthens the strategic role of the NIT	(Reina; Thomaz; Magalhães, 2021; Pires <i>et al.</i> , 2023)
	Institutional learning generated and challenges overcome	Strategic value of the experience	(Machado <i>et al.</i> , 2023; Reina; Thomaz; Magalhães, 2021)
	Legal instruments employed (agreement format and partnership type)	Promotes flexibility and legal certainty	(Carvalho e Renault, 2019)
Operational	Tangible products and deliverables resulting from the partnership	Generates tangible societal impact	(Reina; Thomaz; Magalhães, 2021; Freitas e Lago, 2019)
	Attraction and mobilization of external resources	Overcomes budgetary constraints	(Freitas e Lago, 2019; Paiva <i>et al.</i> , 2023)
	Degree of replicability and scalability of the model	Enables learning and adaptation in other contexts	(Paiva <i>et al.</i> , 2023; Carneiro <i>et al.</i> , 2022)

Source: Prepared by the authors (2025)

3.1 Development of the Analytical Categories Based on the Literature

The analytical categories applied to the evaluation of the partnerships established by ICEPi were defined through a critical review of the literature addressing the main challenges faced by Technological Innovation Centers (NITs) in Brazil. The studies conducted by Paranhos and Ribeiro (2018), Reina, Thomaz, and Magalhães (2021), Alcântara, Borschiver, and Alencar (2021), Carvalho and Renault (2019), Freitas and Lago (2019), Paiva *et al.* (2023), Pires and Silva (2023), Machado *et al.* (2023), and Carneiro *et al.* (2022) were instrumental in systematizing the factors that either constrain or enhance the performance of NITs in activities such as technology scouting, technology transfer, intellectual property management, and partnership development.

Through a cross-analysis of these studies, recurring patterns of recommendations and bottlenecks were identified and organized into three broad dimensions: institutional, operational, and legal. Each dimension reflects a specific set of organizational and contextual capabilities, as described below.

Institutional factors relate to the capacity of the STII/NIT to align its actions with its strategic mission

(Carneiro *et al.*, 2022; Machado *et al.*, 2023), to coordinate diverse stakeholders around shared objectives (Alcântara, Borschiver, & Alencar, 2021; Reina, Thomaz, & Magalhães, 2021), to integrate teaching, research, and management activities (Paranhos & Ribeiro, 2018), to mobilize internal capabilities (Reina, Thomaz, & Magalhães, 2021; Pires & Silva, 2023), to generate organizational learning (Machado *et al.*, 2023; Reina, Thomaz, & Magalhães, 2021), and to employ legal instruments appropriate to the nature of the partnerships, thereby ensuring regulatory certainty and flexibility for innovation (Carvalho & Renault, 2019).

Operational factors focus on the tangible outcomes generated through partnerships, including the delivery of products, systems, and services (Reina, Thomaz, & Magalhães, 2021; Freitas & Lago, 2019), the capacity to attract and coordinate financial and human resources (Freitas & Lago, 2019; Paiva *et al.*, 2023), and the potential for replication or scaling of the developed solutions (Carneiro *et al.*, 2022; Paiva *et al.*, 2023).

This systematization made it possible to transform the challenges identified in the literature into practical criteria for evaluating institutional experiences, enabling a structured analysis of the partnerships under investigation in light of the conceptual frameworks that guide the activities of Technological Innovation Centers in Brazil.

3.2 Analysis of the Programs and Projects

The following analysis details the initiatives that constitute the corpus of this study, focusing on the implementation of public health innovation. To better understand the implementation dynamics and the social impact achieved, the Viana Vacinada, ProticSUS, and Qualifica-APS projects are examined through the lens of interinstitutional arrangements and the technical capabilities mobilized by the state public Scientific, Technological, and Innovation Institution.

3.2.1 Qualifica-APS Programme

The State Program for the Qualification of Primary Health Care (Qualifica-APS), launched in 2019, was the first program established by ICEPi. The program aims to train and qualify healthcare professionals in strategic areas for the Unified Health System (SUS) in order to expand access to Primary Health Care (ICEPi, 2022a).

The diversity and complementarity of the partners involved were of fundamental importance to the program's success. All 78 municipalities of the State of Espírito Santo participated in the initiative. Cooperation agreements and shared responsibilities were formalized between the state and municipal governments through the Bipartite Intermanagerial Commission (CIB) by means of Resolution No. 104, issued on July 22, 2019, in addition to the participation of the Ministry of Health. More specifically, partnerships with municipalities were formalized through cooperation agreements between the Espírito Santo State Health Secretariat (SESA), through ICEPi, and each municipality. It is noteworthy that the establishment of residency programs was authorized by the Ministry of Health, the federal body responsible for coordinating and promoting programs, projects, and public policies related to Health Residencies.

Program management was carried out through a decentralized governance model based on Bipartite Intermanagerial agreements, a mechanism for coordination and negotiation between municipal and state managers of the Unified Health System (SUS) within each state's Bipartite Intermanagerial Commission (CIB). ICEPi was responsible for overall project coordination, development of the educational framework, and selection of participants, applying its expertise in continuing health education, pedagogical coordination, and intergovernmental collaboration.

Resource allocation involved multiple levels of government, including municipal, state, and federal entities. Municipal governments were responsible for providing

training practice settings and financing professional training scholarships (Espírito Santo, 2019). The State of Espírito Santo and the Ministry of Health jointly financed residency scholarships until 2024. Beginning in 2025, this responsibility became exclusively assigned to the Ministry of Health.

The program achieved significant results. A total of 5,079 professional qualification certificates were issued. Among these, 694 professionals completed the Advanced Training Program in Interprofessional Practice in Primary Health Care, 81 completed the Advanced Training Program for Street Clinic Services, 1,505 completed the Advanced Training Program in Nursing, 1,596 completed the Advanced Training Program in Medicine, and 766 completed the Advanced Training Program in Dentistry, totaling 4,642 advanced training certificates. Furthermore, the program supported the creation of medical and multiprofessional residency programs operating in 15 municipalities and covering all health regions of the state. To date, 437 residents have successfully completed their training.

Program activities integrate in-service education, territorially based extension activities, and institutional support for municipal health management. Residency programs and advanced training courses are conducted within primary healthcare units, hospitals, and SUS healthcare services, fostering direct integration among education, clinical practice, and health management. In this context, the program demonstrates considerable potential for replication across different healthcare settings, including hospitals, specialized services, and primary care facilities, provided that clear and structured agreements are established among stakeholders and governmental entities. The model can also be scaled through the inclusion of higher education institutions as formal partners in cooperation agreements.

Among the key lessons learned are the importance of intergovernmental coordination, territorially oriented professional training, and continuous technical support. The main challenges included the diversity of municipal contexts, the need for ongoing coordination with local administrations, and the limited availability of professionals interested in training opportunities in some rural regions of the state. It is important to note that, during the initial development of Qualifica-APS, ICEPi had not yet formally established its Technological Innovation Center (NIT). Nevertheless, the experience gained through the formalization of cooperation agreements and project management contributed significantly to the consolidation of this strategic unit, preparing the Institute to expand its innovation activities.

3.2.2 ProticSUS Program

The Program for the Development of Information and Communication Technologies and the Promotion of Innovation Applied to Health (ProticSUS) was established in January 2020. The program aims to support the development, implementation, and improvement of digital health solutions and their integration into the Espírito Santo Unified Health System (SUS), thereby contributing to the enhancement, expansion, and strengthening of health management.

During its initial phase, the program was developed through the collaboration between the Espírito Santo Institute for Teaching, Research, and Innovation in Health (ICEPi) and the Information Technology Management Office (GTI) of the State Health Secretariat (SESA), involving several permanent public servants. This institutional collaboration sought to promote knowledge management and foster the dissemination of an innovation culture within the organization. ProticSUS is coordinated by ICEPi in continuous collaboration with the Information Technology Management Office. Its governance model is based on multidisciplinary teams composed of researchers, systems analysts, and public servants, promoting co-production and shared management of the solutions developed. ICEPi served as both a technical coordinator and a knowledge management hub, leveraging its organizational structure and expertise in public sector innovation. At the time of this program's implementation, ICEPi had already established its Technological Innovation Center (NIT), enabling it to exercise its institutional competencies in supporting the development of innovative solutions and facilitating relationships with partner institutions.

Within the scope of this program, several digital health solutions were developed through partnership agreements with other institutions, including the Federal Institute of Rio Grande do Norte (IFRN) and the Federal University of Rio Grande do Norte (UFRN). Box 2 presents the products and deliverables generated by the project, as well as the partners involved in the development of each solution.

Unlike traditional technology procurement and service contracting arrangements, ProticSUS was structured as a co-production agreement among public institutions. Technical and scientific partnerships were formally established based on collaboratively defined objectives, allowing greater flexibility and adaptation of deliverables to the needs of public health management. The partnership among ICEPi, universities, public agencies, and public institutions was instrumental in advancing the development of digital solutions for health innovation. Through cooperation among these actors, it was possible to reallocate human resources and share technical expertise for software development. The redeployment of qualified professionals and interinstitutional collaboration generated significant gains without the need for substantial additional financial investments. The program promotes the integration of knowledge and expertise with a focus on technological development by bringing together universities,

public management professionals, and information technology specialists.

ICEPi's Technological Innovation Center (NIT) played a key role in formalizing the partnerships and subsequently registering the digital solutions with the Brazilian National Institute of Industrial Property (INPI). In cases of co-produced technologies, such as the software platforms *Vacina e Confia* and *Sares*, developed in partnership with UFRN and IFRN, ownership rights were shared among ICEPi, UFRN, and IFRN. In the remaining cases, ownership belongs exclusively to ICEPi. Technology transfer requests for these solutions have been submitted by other state health departments and by the Ministry of Health. In response, ICEPi's NIT has actively supported these demands in order to facilitate the transfer of the developed technologies.

Among the principal lessons learned was the consolidation of a public innovation model based on the co-production of technological solutions among public institutions. Unlike conventional service contracts, ProticSUS operates through collaborative agreements between public organizations, with jointly defined objectives and deliverables tailored to local needs. The inclusion of researchers, systems analysts, and permanent public servants in multidisciplinary teams fostered the integration of scientific and technical knowledge with operational realities. This experience reinforces the notion that the State can act as a strategic driver of innovation, moving beyond traditional and fragmented models of Information and Communication Technology (ICT) procurement.

Among the main challenges encountered was the difficulty of identifying flexible partnership models within the public sector that were suitable for innovation initiatives. This obstacle was overcome through the adoption of co-production agreements among public institutions as an alternative to traditional service contracting arrangements. Furthermore, the initial challenge of aligning scientific and technical expertise with management practices was addressed through the creation of multidisciplinary teams composed of researchers, systems analysts, and public servants, promoting integration among science, technology, and territorial governance. Finally, financial resource constraints were mitigated through the redeployment of qualified personnel and the utilization of existing institutional capabilities within partner organizations, thereby avoiding the need for substantial new investments.

3.2.3 Viana Vacinada Project

The Viana Vacinada project, established in July 2021, was designed primarily as an applied research initiative to evaluate the efficacy, safety, and immunogenicity of an adjusted dosing regimen of the ChAdOx1 nCoV-19 (AZD1222) COVID-19 vaccine in a population-based

Box 2 – Digital Solutions Developed Within the Scope of ProticSUS

DIGITAL SOLUTION	OBJECTIVE	PARTNERS AND LEGAL INSTRUMENT
Vacina e Confia	Developed during the COVID-19 pandemic to support municipalities in the State of Espírito Santo in online vaccination scheduling and immunization monitoring. With more than four million registrations, the system integrates SUS immunization data, enabling the monitoring of daily vaccination indicators, issuance of vaccination certificates, and management of vaccine inventories.	- State Health Secretariat (SESA), SESA Information Technology Management Office, ICEPi, Federal University of Rio Grande do Norte (UFRN), and Federal Institute of Rio Grande do Norte (IFRN). - Partnership Agreement.
Integra BPA	Optimizes the workflow of Specialized Care health units and the Central Public Health Laboratory of the State of Espírito Santo by integrating the Multimunicipal e-SUS APS system with the Laboratory Environment Management System. The solution aims to automate data entry processes and the generation of reports on service production and performance.	- State Health Secretariat (SESA), ICEPi, and the Central Public Health Laboratory of Espírito Santo. - Internal Administrative Arrangement.
Caça-Dengue	An educational game designed to promote dengue prevention through a playful and interactive approach while encouraging actions to combat the <i>Aedes aegypti</i> mosquito, the primary vector responsible for disease transmission.	- State Health Secretariat (SESA), Health Surveillance Undersecretariat, and ICEPi. - Internal Administrative Arrangement.
Digital Solution Applied to Healthcare Regulation in Espírito Santo (Sares)	A digital solution designed to optimize outpatient healthcare regulation within the public health network, focusing on reducing patient waiting times, increasing transparency, and promoting equity in access to diagnostic examinations and hospital beds.	- State Health Secretariat (SESA), SESA Information Technology Management Office, ICEPi, Federal University of Rio Grande do Norte (UFRN), and Federal Institute of Rio Grande do Norte (IFRN). - Partnership Agreement.
Alta Pró +	Software developed to assist hospitals in improving discharge planning and patient transition processes. The platform enables healthcare professionals to record and monitor key discharge-related activities, as well as to track patients following hospital discharge	- State Health Secretariat (SESA), ICEPi, and hospitals within the state-owned healthcare network. - Internal Administrative Arrangement.

Source: Prepared by the authors (2025)

setting, specifically in the municipality of Viana, Espírito Santo. The study sought to generate scientific evidence capable of informing immunization and health surveillance policies, thereby contributing to Brazil's response to the COVID-19 pandemic (Espírito Santo, 2021; ICEPi, 2022b).

The project was developed through a partnership involving the Government of the State of Espírito Santo, ICEPi, the Municipal Health Secretariat of Viana, the Oswaldo Cruz Foundation (Fiocruz), the Federal University of Espírito Santo (UFES), the Ministry of Health (MoH), the Pan American Health Organization (PAHO), and the Cassiano Antonio Moraes University Hospital (Hucam). Each partner contributed distinct and complementary capabilities, including local logistics,

laboratory infrastructure, scientific expertise, international coordination, and financial support. Institutional complementarity was one of the key pillars underpinning the feasibility and success of the initiative. The logistical complexity of the project, which involved large-scale scheduling, clinical and laboratory data collection, and longitudinal monitoring, required agile integration among federal, state, and municipal authorities, as well as field teams and reference laboratories.

The project generated unprecedented epidemiological surveillance protocols, scientific publications in national and international journals, technical reports, and clinical datasets that supported public policy decision-making. It also brought national visibility to the State of Espírito Santo due

to its methodological innovation and rapid response capacity during a public health emergency (Valim *et al.*, 2022).

Project coordination was led by ICEPi, with technical support from SESA. Its management required intersectoral planning, coordination among different levels of government and international organizations, and the formation of highly integrated field and research teams. Decision-making structures were established to ensure the efficient operation of research activities. The project represents a robust example of integration among academia, public administration, and healthcare services. Researchers from UFES were incorporated into ICEPi's technical team and worked alongside professionals from SESA and the Municipal Health Secretariat of Viana. The training of research fellows, scientific dissemination activities, and the incorporation of research findings into health surveillance practices further exemplified this integration. Through its Technological Innovation Center (NIT), ICEPi played a central role in interinstitutional coordination, resource management, and technical and scientific leadership.

The attraction and mobilization of resources, both financial and non-financial, involved multiple sources. The Ministry of Health supplied the vaccines, while PAHO and SESA contributed supplies and physical infrastructure. UFES and Fiocruz provided research facilities and scientific and technical expertise. Research fellowships were financed by ICEPi using resources from the Government of the State of Espírito Santo.

Although the project was developed under exceptional circumstances during the early stages of the pandemic, before vaccines became widely available, its model is replicable in similar public health emergency contexts. However, successful replication requires substantial interinstitutional coordination capacity, specialized human resources, and coordinated political and technical support. Among the principal lessons learned was the importance of intermediary institutional structures, such as ICEPi, in facilitating the interface between academia and local public administration, as well as the need for flexible legal frameworks capable of enabling rapid responses during emergency situations. The primary challenges encountered included the logistics of mass vaccination, rapid population mobilization, and coordination among institutions with distinct organizational cultures.

3.2.4 Analytical Synthesis

This section presents the analysis derived from applying the analytical categories developed in this study (Box 1) to the three experiences examined: Viana Vacinada, ProticSUS, and Qualifica-APS. Box 3 provides a synthesis of the analytical findings.

Although distinct in scope and format, the three experiences analyzed share key characteristics that reveal a consistent trajectory of innovation. The programs and projects demonstrate the strategic role of ICEPi as a catalyst for public sector cooperation, acting as an intermediary institution capable of translating societal demands into technically viable initiatives. The main findings associated with each analytical category are discussed below and interpreted in light of the relevant literature.

“Clear objectives aligned with the mission of the STII/NIT”: The analysis revealed a strong alignment between the objectives of the partnerships and ICEPi's mission as a public Scientific, Technological, and Innovation Institution dedicated to strengthening the Unified Health System (SUS). The Viana Vacinada project directly addressed the public health emergency posed by the COVID-19 pandemic by combining applied scientific research with territorial health management. ProticSUS focused on the modernization and digital transformation of healthcare services, whereas Qualifica-APS invested in the qualification of healthcare professionals to expand access to Primary Health Care throughout the state. These findings reinforce the arguments advanced by Carneiro *et al.* (2022) and Machado *et al.* (2023), who emphasize that alignment between institutional mission and implemented actions enhances both the relevance and sustainability of NITs within innovation ecosystems.

“Diversity and complementarity of partners”: The analysis demonstrates that all three initiatives mobilized extensive interinstitutional networks involving universities, public agencies, and municipal health managers. Qualifica-APS engaged all 78 municipalities of the state through formal cooperative arrangements. ProticSUS brought together federal educational institutions (UFRN and IFRN), technical departments of SESA, and ICEPi personnel. Viana Vacinada involved collaboration among international organizations (PAHO), national institutions (Fiocruz and the Ministry of Health), and local partners (UFES and the Municipality of Viana). According to Alcântara, Borschiver, and Alencar (2021) and Reina, Thomaz, and Magalhães (2021), such diversity and convergence of competencies are critical factors in enhancing the innovative capacity of STIIs, as they facilitate the combination of academic, technical, and operational expertise in the development of more effective solutions.

“Integration of teaching, research, extension, and management activities”: The three initiatives reveal different forms of integration among these dimensions. Qualifica-APS combined in-service training with the reorganization of healthcare delivery. ProticSUS involved researchers and public management professionals in the development of digital solutions. Viana Vacinada generated scientific evidence in real time through collaboration among managers, researchers, and universities. These experiences

Box 3 – Synthesis of the programs and projects analyzed in light of the analytical categories

ANALYTICAL CATEGORY	PROGRAMS/PROJECTS ANALYZED		
	VIANA VACINADA	PROTICSUS	QUALIFICA-APS
Clear objectives aligned with the mission of the STII	Yes. Pandemic response combined with applied scientific research.	Yes. Modernization and digitalization of health services through digital solutions.	Yes. Strengthening Primary Health Care (PHC) in Espírito Santo and decentralizing public health management.
Diversity and complementarity of partners	High. UFES, Fiocruz, PAHO, Ministry of Health, Municipality of Viana, HUCAM, LACEN-ES, SESA, and ICEPi.	High – IFRN, UFRN, SESA, and ICEPi.	High – All municipalities in Espírito Santo, ICEPi, SESA, and CIB.
Tangible products and deliverables resulting from the partnership	Epidemiological data, scientific publications, and studies evaluating the effectiveness and efficacy of the adjusted AstraZeneca vaccine dosing regimen.	Digital platforms and systems currently in use (technology transfer under evaluation).	Expanded health coverage and 5,079 trained professionals.
Legal instruments employed (agreement format and partnership type)	Interinstitutional cooperation agreement for applied research	Interinstitutional cooperation agreement, implementation agreements, and public technology procurement contracts.	Cooperation agreement.
Integration of teaching, research, extension, and management activities	Research and Extension	Research, Development, and Management.	Teaching
Attraction and mobilization of external resources	Sources: MS, Fiocruz, OPAS, Prefeitura Municipal de Viana, UFES and Hucam. Ministry of Health: provision of vaccines. UFES and Fiocruz: provision of human resources, including researchers. Fiocruz also provided laboratory infrastructure. Municipality of Viana: facilities for conducting mass vaccination campaigns and blood sample collection. HUCAM: physical infrastructure for the storage of vaccines and genetic materials. PAHO: donation of materials required for the development of the research project	Sources: UFRN and IFRN. Human resources (researchers).	Source: Scholarships funded by the municipalities.
Application of the NIT's internal capabilities	NIT responsible for the formalization and coordination of the partnership agreement.	NIT responsible for the formalization and coordination of partnership agreements, stakeholder engagement, intellectual property registration of the developed solutions, and negotiation of technology transfer processes.	The partnership agreements were formalized before the establishment of ICEPi's Technological Innovation Center (NIT). As a result, the STII gradually accumulated the institutional experience and technical expertise necessary to create and consolidate its own NIT.

Continue

Continuation

ANALYTICAL CATEGORY	PROGRAMS/PROJECTS ANALYZED		
	VIANA VACINADA	PROTICSUS	QUALIFICA-APS
Degree of replicability and scalability	Moderate. The model serves as an inspiring and adaptable framework for implementation in other municipalities	High. The solutions can be adapted to different contexts and present strong potential for technology transfer and broader adoption of the digital tools developed.	Moderate. Replication depends on intergovernmental coordination, local management capacity, and sustained institutional commitment.
Institutional learning generated and challenges overcome	Lessons learned: the importance of rapid response capacity in a public health emergency, effective coordination among multiple external stakeholders, and the application of scientific research to health resource management. Challenges overcome: the logistics of mass vaccination, rapid population mobilization, and coordination among institutions with distinct organizational cultures represented significant challenges throughout the implementation of the project.	Lessons learned: the co-production of customized ICT solutions for public management, emphasizing technical consultation, collaborative development processes, and the strengthening of relationships among public institutions in the creation of technological solutions.	Lessons learned: federative cooperation combined with territorially oriented technical support can serve as an effective strategy for strengthening Primary Health Care (PHC).

are consistent with the arguments of Paranhos and Ribeiro (2018) and Alcântara, Borschiver, and Alencar (2021), who emphasize that integrating traditional academic functions with public administration is essential for promoting innovations capable of generating tangible societal impact.

“Application of the NIT’s internal capabilities”: The analysis indicates that ICEPI’s Technological Innovation Center played different roles across the projects, reflecting its own process of institutional maturation. In Qualifica-APS, partnership agreements were established before the formal creation of the NIT, although the experience contributed significantly to its subsequent structuring. In contrast, within ProticSUS and Viana Vacinada, the NIT actively participated in the formalization of agreements, intellectual property registration processes, and institutional coordination activities. This trajectory confirms the strategic importance of NITs as organizational units responsible for consolidating and sustaining innovation activities, as highlighted by Reina, Thomaz, and Magalhães (2021) and Pires and Silva (2023).

“Institutional learning generated and challenges overcome”: The experiences examined produced a wide range of institutional learning outcomes. Viana Vacinada highlighted the importance of intermediary institutional structures and organizational agility in responding to public health emergencies. ProticSUS demonstrated the potential of technological co-production among public institutions. Qualifica-APS underscored the value of federative coordination and territorially oriented technical support.

These findings are consistent with the arguments of Reina, Thomaz, and Magalhães (2021) and Machado *et al.* (2023), who identify institutional learning as a strategic asset for strengthening public sector innovation capacity.

“Products and deliverables”: Each initiative generated high-impact outputs. Viana Vacinada produced scientific evidence and unprecedented epidemiological surveillance protocols. ProticSUS resulted in digital platforms adopted on a large scale across the public health system. Qualifica-APS trained thousands of healthcare professionals in strategic areas for the SUS. These deliverables demonstrate tangible societal impact, reinforcing the arguments of Freitas and Lago (2019) and Reina, Thomaz, and Magalhães (2021), who identify the generation of concrete solutions as one of the principal indicators of effectiveness in technological and innovation partnerships.

“Attraction and mobilization of external resources”: The projects also differed in terms of the origin and mobilization of resources. Viana Vacinada leveraged resources provided by the Ministry of Health, PAHO, and Fiocruz. ProticSUS benefited from the allocation of personnel from partner universities, while Qualifica-APS was financed through federal and municipal funding mechanisms. This diversity is consistent with the arguments advanced by Paiva *et al.* (2023) and Freitas and Lago (2019), who emphasize that the sustainability of NITs depends on multiple funding and resource mobilization strategies, particularly in contexts characterized by budgetary constraints.

“Degree of replicability and scalability of the model”: The analysis revealed varying levels of replication potential among the initiatives. Viana Vacinada presents strong potential for replication in public health emergency contexts. ProticSUS generated digital solutions that are suitable for technology transfer and adoption by other institutions. In contrast, the replication of Qualifica-APS depends largely on local intergovernmental agreements and implementation capacity. These findings are aligned with Carneiro *et al.* (2022) and Paiva *et al.* (2023), who argue that the ability to scale successful experiences is essential for the broader dissemination of innovation.

“Legal instruments employed”: The initiatives analyzed relied on different legal arrangements, including cooperation agreements, implementation agreements, and administrative arrangements. The adoption of flexible yet legally robust instruments was decisive in enabling project implementation within the required timelines and operational conditions, particularly in the cases of Viana Vacinada and ProticSUS. Consistent with the arguments of Carvalho and Renault (2019), the adequacy of legal and regulatory frameworks emerges as a key factor in ensuring both legal certainty and agility in public sector innovation processes.

4 Final Considerations

This article analyzed three initiatives conducted by the Espírito Santo Institute for Teaching, Research, and Innovation in Health (ICEPi), namely Viana Vacinada, ProticSUS, and Qualifica-APS, with the objective of identifying institutional learning associated with the development of partnerships that generate tangible contributions to the Unified Health System (SUS). Drawing on analytical categories derived from the literature addressing the challenges faced by Scientific, Technological, and Innovation Institutions (STIIs) and Technological Innovation Centers (NITs) in Brazil, it was possible to develop a structured framework for analysis.

The comparative analysis revealed that the success of the institutional partnerships examined was less dependent on the availability of financial resources and more closely associated with the development of innovative institutional arrangements. Across all cases, the factors most strongly associated with effective outcomes were: (i) the clear definition of objectives aligned with the mission and strategic priorities of the STII; (ii) qualified interinstitutional coordination through diverse and complementary partnerships involving universities, public agencies, and municipal or state administrations; (iii) the adoption of flexible legal instruments suited to the collaborative nature of the projects, thereby ensuring both agility and legal certainty during implementation; (iv) the co-production of

solutions through the integration of scientific, technical, and territorial knowledge, which enhanced their responsiveness to the needs of the SUS; and (v) the strengthening of ICEPi’s internal technical capabilities, particularly through the structured involvement of its NIT in partnership formalization, intellectual property management, and the articulation between innovation activities and public policy objectives. These findings reinforce conclusions reported in the specialized literature (Carneiro *et al.*, 2022; Reina, Thomaz, & Magalhães, 2021; Mazzucato, 2014; Alcântara, Borschiver, & Alencar, 2021), which emphasize that innovation in public sector environments depends on collaborative structures, active state leadership, and the strengthening of institutional capabilities within STIIs.

The study further demonstrates that tangible outcomes in social innovation in health emerged from the consistent interaction between institutional and operational factors. From an institutional perspective, the clarity of strategic objectives, the diversity and complementarity of partners, the integration of teaching, research, and management activities, the effective utilization of the NIT’s internal capabilities, and the adoption of appropriate and flexible legal instruments were decisive in aligning partnerships with the missions of both the STII and the SUS. From an operational perspective, the delivery of relevant products and services, the mobilization of external resources, and the potential for replication contributed directly to expanding the impact of these initiatives across different territories. By organizing the analysis around these analytical categories, this article also offers a methodological framework that can be applied to other studies and institutional contexts, thereby strengthening the connection between theory and practice.

From a theoretical standpoint, the article contributes to the field of public innovation in health by demonstrating that the capacity to generate socially relevant solutions depends not merely on the availability of resources but on the development of institutional arrangements guided by collaboration, scientific knowledge, and the state’s ability to provide technical and strategic leadership. From a practical perspective, the findings reinforce the role of NITs as innovation-enabling structures within public STIIs, capable of coordinating complex processes, fostering the co-production of technological solutions, and promoting the institutionalization of innovative cooperation models.

In this regard, the study highlights the significant role played by ICEPi’s NIT within the public innovation ecosystem analyzed, given its close involvement in the innovation projects undertaken by the institution. Even before the formal establishment of the NIT, ICEPi had already mobilized its technical staff to develop and manage partnership agreements. Following the creation of the NIT, the unit assumed an active role in the legal formalization of partnerships, intellectual property registration, and

technology transfer negotiations. This close engagement generated important benefits, particularly through the alignment and contextual understanding acquired by the NIT as it participated throughout the entire innovation process, from project conception to final consolidation, culminating in the protection and, where applicable, transfer of intellectual property assets. These findings suggest that when a NIT is integrated into partnerships from their earliest stages, the likelihood of successful implementation, institutionalization, and dissemination of the resulting solutions is significantly enhanced.

5 Future Perspectives

Os autores entendem que outros estudos podem ser realizados no sentido de se aprofundar no entendimento das dificuldades/desafios enfrentados por ICTs e NITs (em especial, com ICTs não universitárias) no contexto da inovação, em especial, com a proposição de instrumentos avaliativos e com relatos de soluções/estratégias exitosas como forma de se criar/ampliar uma base compartilhada de boas-práticas. O desenvolvimento de modelos avaliativos que identifiquem níveis de desenvolvimento institucional, governança e integração com políticas públicas seria relevante no cenário atual. Estudos comparativos poderiam sistematizar práticas bem-sucedidas de articulação entre ciência, gestão e território, facilitando a criação de manuais, roteiros ou indicadores que orientem outros entes públicos. Ademais, estudos que foquem a mensuração de impacto das parcerias em termos de transformações de serviços, melhorias de indicadores de saúde e sustentabilidade das inovações seriam muito relevantes também. Estudos de impacto das políticas públicas desenvolvidas através das iniciativas discutidas neste trabalho poderiam enriquecer a discussão acerca de avaliação de impacto e de custo-benefício, desenvolvimento de políticas públicas baseadas em evidências e cuidado da saúde baseado em valor.

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