Governance of Reesearch and Innovation Networks in the National Institutes of Science and Technology (INC)

Márcio Aldrin França Cavalcante[1]*, Thiago Barros Murari[2], Cristiano Vasconcellos Ferreira[3]
[1]Oswaldo Cruz Foundation; Salvador, Bahia; [2]SENAI CIMATEC University; Salvador, Bahia; [3]Federal University of Santa Catarina; Joinville, Santa Catarina, Brazil

This study aimed to investigate and characterize current knowledge regarding research and innovation networks primarily formed by researchers and the governance mechanisms present in the National Institutes of Science and Technology (INCT). To this end, an exploratory study was conducted to understand the environmental context, operational dynamics, and composition of actors within these institutes. The findings revealed a strong predisposition toward establishing research network environments comprising individual and institutional actors. Most INCTs operate through institutional mechanisms in governance, primarily structured around coordination bodies and management committees.
Keywords: Network Governance. Research and Innovation Networks. Institutes of Science and Technology.

The advent of the information and knowledge era has significantly transformed organizations, making them more adaptable. Within this new context, it has become necessary to revise core organizational strategies, including: (i) the flexibilization of infrastructure, making it more horizontal; (ii) the organizational culture, associated with the profiles of its actors; and (iii) a predisposition toward the intensive use of information and communication technology tools [1–3].

This transformation in organizational and societal environments has amplified the use of network structures as spaces for collaborative production. Simultaneously, governance and management structures have emerged as essential mechanisms for guiding decisions and operationalizing actions within these networks. In this regard, it is critical to consider the factors involved in forming and structuring networks to inform the adoption of more suitable governance models. The literature highlights several key aspects: trust among actors, the quality of relationships, network structure and coordination, mobilization, knowledge sharing, consensus on norms, objectives, and results, and network sustainability [4–9].

Research on network governance addresses elements related to the configuration of decision-making environments, such as rules, sanctions, formal agreements, and control mechanisms. These also encompass coordination and leadership, typically discussed in the context of relationships among network members [10]. Governance mechanisms that foster and enhance the participation of network actors via platforms are characterized by knowledge sharing, capacity and resource assessment, metric development and communication, and the adaptation of resources and routines [11].

The INCT Program was established through an initiative of the Ministry of Science, Technology, and Innovation (MCTI) and implemented by the National Council for Scientific and Technological Development (CNPq). Its goal is to expand funding opportunities for broad and impactful scientific research and technological development projects.

The program is grounded in several core pillars: (i) the formation of research networks, (ii) the consolidation of institutional partnerships, (iii) a multidisciplinary approach to strategically important national themes, (iv) the training and

Received on 7 January 2025; revised 28 March 2025.
Address for correspondence: Márcio Aldrin França Cavalcante. Rua Waldemar Falcão, 121 - Candeal, Salvador, Bahia, Brazil. Zipcode: 40296-710. E-mail: marcio.cavalcante@ba.estudante.senai.br

J Bioeng. Tech. Health 2025;8(2):217-222

qualification of highly skilled human resources, and (v) long-term investment. The INCT Program replaced the Millennium Institutes Program through MCT Ordinance No. 429, dated July 17, 2008, and was reissued in 2014 via MCTI Ordinance No. 577, dated June 4, 2014. Its mission is to mobilize and cohesively integrate excellence groups in frontier and strategic scientific areas essential for the country's sustainable development [12].

Given this context, and to expand the understanding of governance structures within research and innovation networks, this study seeks to characterize the current knowledge regarding researcher network formation and governance mechanisms in science and technology institutes. The research focuses on the INCT Program, which addresses themes across major knowledge areas: Agricultural Sciences, Energy, Engineering and Information Technology, Exact and Natural Sciences, Humanities and Social Sciences, Ecology and Environment, Nanotechnology, and Health.

Materials and Methods

This study employed an exploratory and descriptive research design. Data collection techniques included extracting secondary data from scientific databases and public documents available on institutional and government websites to support the analysis of governance-related information within the INCT.

A detailed review of each INCT was performed to identify data indicating the presence of network formation and/or governance mechanisms. However, the investigation encountered limitations due to some INCT websites being non-functional or duplicated, often linked to the institutional websites of federal higher education institutions (IES).

An extensive analysis was also conducted to understand the interaction dynamics and network formation among the INCTs. Data on research themes and inter-institute connections were collected between September and October 2023. Through an exploratory approach, directed links on the web pages were mapped, and the data were organized into a spreadsheet for database construction. This structure enabled the application of Social Network Analysis (SNA), providing deeper insights into the relationships identified.

Results and Discussion

A comprehensive analysis was conducted on 159 institutional websites identified between August and October 2023. Of these, 112 were functional, allowing for the investigation of network formation initiatives and associated governance mechanisms. However, 47 websites had non-functional links, limiting data collection from those sources.

Table 1 presents a summary of INCT websites distributed by the central area of knowledge. Based on the information collected, the INCT Program currently includes 104 active institutes and engages 2,300 institutions, 12,000 researchers, and 485 partnerships with public and/or non-governmental organizations. In human resource development, 79 graduate programs have been created, encompassing 566 courses and the training of 12,700 researchers. Seven hundred eighty-seven agreements have been signed regarding international cooperation, involving 1,318 international researchers, 154 companies, and 592 associated laboratories. Regarding scientific, technological, and innovative outputs, the program has generated 79,000 academic publications, filed 1,410 patent applications, and has 12 patents in the market [13].

In a recent initiative to expand and strengthen the Program, CNPq launched the INCT Call – CNPq No. 58/2022. This call included funding from the National Fund for Scientific and Technological Development (FNDCT) and was carried out in partnership with the coordination for the Improvement of Higher Education Personnel (CAPES) and the State Research Support Foundations (FAPs). As a result, more than 100

Table 1. Overview of the operational status of the hotsites investigated.

SITES ORGANIZED BY MAJOR KNOWLEDGE AREAS
Agrarian- 19 sites - 11 operational
Energy - 6 sites - 4 operational
Engineering and Information Technology - 22 sites - 18 operational - 1 duplicated
Health - 46 sites - 32 operational
Nanotechnology - 5 sites - 5 operational
Humanities and Social Sciences - 13 sites - 12 operational
Exact and Natural Sciences - 10 sites - 10 operational
Ecology and Environment - 38 sites - 20 operational - 2 duplicated

new INCTs were selected, bringing the total number of institutes in operation across Brazil to 204. This expansion marks another significant milestone in advancing Brazilian science, as it supports research projects of strategic relevance for scientific, technological, and innovation development [12].

The analysis of the INCT institutional websites provided valuable insights into their organizational structures, particularly about their respective areas of expertise. Most institutes operate with institutional governance mechanisms, typically structured around a coordinating body and a managing committee. In some cases, although a formal structure was not explicitly outlined, mechanisms for coordinating the participation and activities of members were still implemented [8].

Several INCTs emphasized the development of virtual environments as alternatives for creating, sharing, and disseminating knowledge. These digital spaces promote communication, enhance interactions and relationships, and foster collaborative learning and knowledge co-creation. In line with the findings of Perks and colleagues (2017), such virtual communities leverage the potential of digital communication to support knowledge exchange and interaction among participants more effectively.

Another notable feature was the formation of research network environments comprising research institutions, universities, individual researchers, and national and international research groups [7]. These networks are typically established either through institutional initiatives focused on advancing specific emerging themes or through organic collaboration among members seeking to share experiences and knowledge and engage in joint production [10].

Figure 1 illustrates the potential of the research networks formed by the institutes and presents the institutional network established within the INCT context. It offers an analysis of eight thematic working groups and their institutional interconnections. These networks encompass major knowledge areas such as Health, Humanities and Social Sciences, Exact and Natural Sciences, Nanotechnology, Ecology and Environment, Engineering and Information Technology, Agrarian Sciences, and Energy. Most of these connections are established through Higher Education Institutions (IES), except for the Energy sector.

The graph presented in Figure 2 enabled the identification of patterns and visualizations of the relationships among network elements, contributing to a more in-depth understanding of the research network's dynamics. INCTs operate through a collaborative research model involving both national and international researchers and institutions. The goal is to

Figure 1 - Network of institutions developed in the context of the INCT.

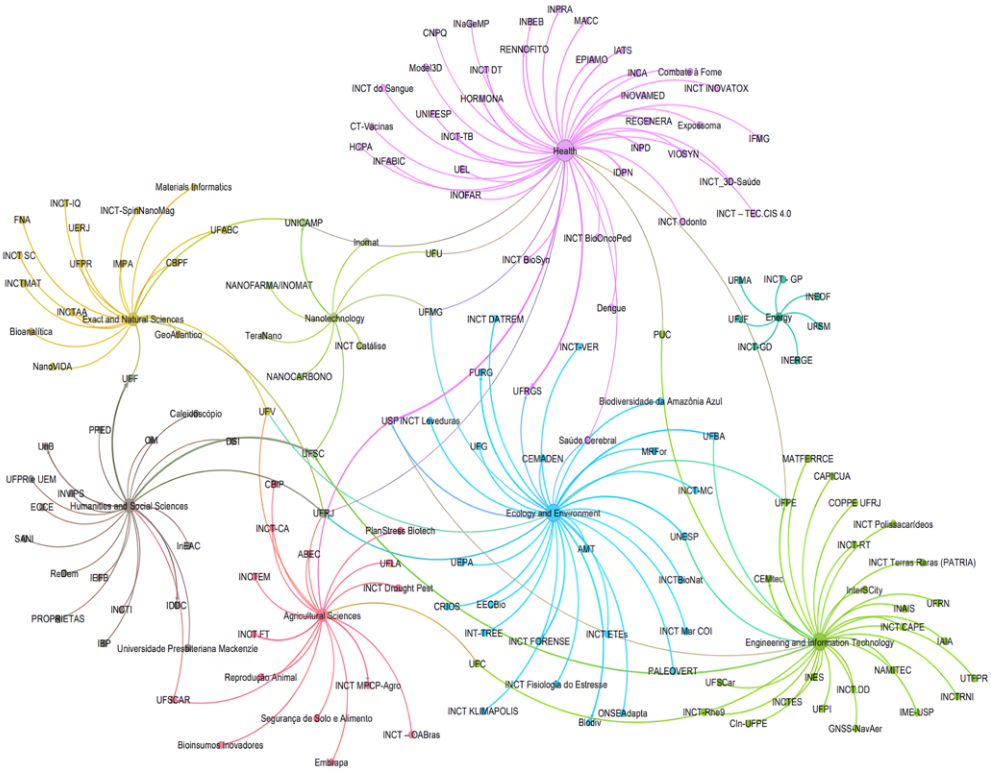
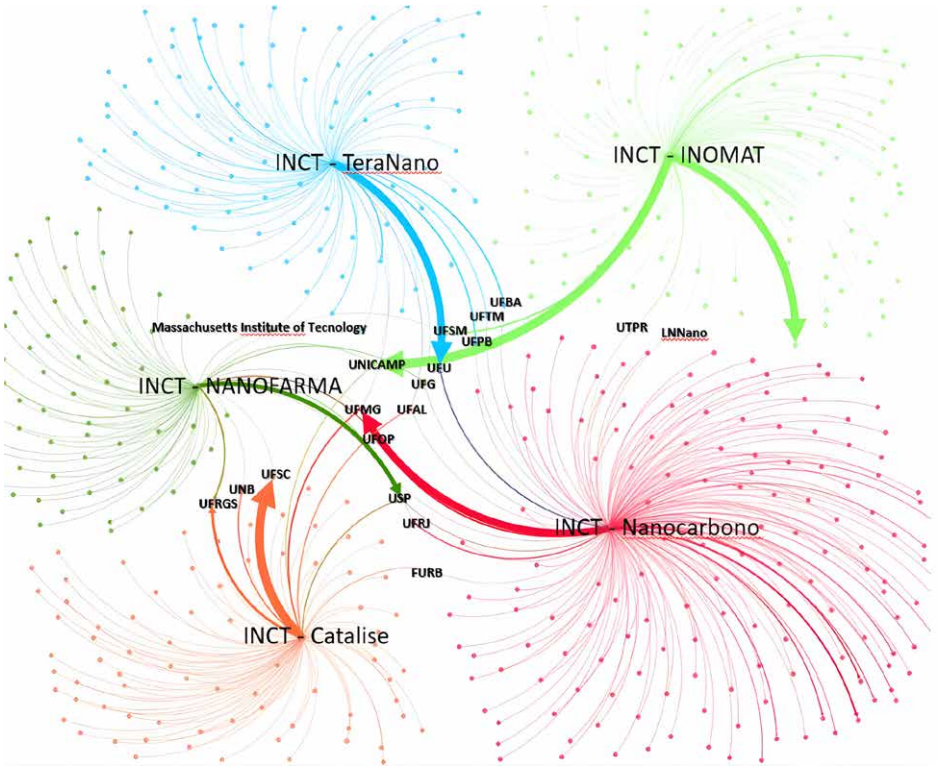


Figure 2 - Network developed under the INCTs for the nanotechnology area.



generate and disseminate knowledge to support the technological development of products and services. These efforts span all significant areas of activity within the institutes, with a central focus on societal benefits and strengthening public policies.

To illustrate this network analysis further, a specific focus was placed on the INCTs operating in Nanotechnology, demonstrating the potential for collaboration among national and international researchers and partner institutions. Notably, INCTs in this field tend to form interconnection hubs primarily through universities. Figure 2 presents the network configuration formed by these institutes, where the nodes represent individual researchers and partner institutions, and the edges indicate the number of established connections. The network comprises 400 researchers and 91 partner institutions, revealing a robust and highly interconnected structure.

The authors Vieira and colleagues (2016), Oliveira, Sanz, and Chaves (2022), Da Costa Filho-Edes and Barbosa (2022), Maia and colleagues (2015), and Ferreira and colleagues (2015) have examined the characteristics of mapping and forming research networks based on scientific collaborations among researchers within the INCTs [14–18]. In this context, it is evident that the research networks established within these institutes, aimed at collaborative and integrated research, serve as a robust coordination mechanism for scientific activity.

Conclusion

The results of this study indicate the existence of institutional governance mechanisms within the INCTs, predominantly structured around coordination bodies and management committees. These research networks comprise universities, research institutions, individual researchers, and research groups—both nationally and internationally. The findings demonstrate the significant potential of these networks in generating, sharing, and transferring knowledge. These environments function as coordination mechanisms that enhance communication, foster relationships and interactions, support collaborative learning, and co-create new knowledge. In this context, developing and implementing effective governance mechanisms within these networks becomes essential to further reinforce coordination and institutional cooperation among researchers and research groups. Such mechanisms are critical for fostering joint project development, maximizing the potential of the research networks, and contributing meaningfully to advancing knowledge to address societal challenges and inform public policy.

Acknowledgements

The authors would like to thank the Oswaldo Cruz Foundation for its support and encouragement in promoting the professional development of its staff. We also thank the SENAI CIMATEC University Center for its valuable partnership and support in providing space during the symposium to present this work.

References

1. Leite FCL, Costa SMS. Gestão do conhecimento científico: proposta de um modelo conceitual com base em processos de comunicação científica. Ci Inf. 2007;36(1):92–107.
2. Pinto AC, Guarieiro LLN, Rezende MJC, Ribeiro NM, Torres EA, Lopes WA, et al. Biodiesel: an overview. J Braz Chem Soc. 2005;16(6B):1313–30.
3. Schwab K. A quarta revolução industrial. Miranda DM, translator. São Paulo: Edipro; 2016.
4. Rogers DL. Transformação digital: repensando seu negócio para era digital. Serra ACC, translator. São Paulo: Autêntica Business; 2020.
5. Agranoff R. Managing within networks: adding value to public organizations. Washington, DC: Georgetown University Press; 2007.
6. Rampersad G, Quester P, Troshani I. Managing innovation networks: exploratory evidence from ICT, biotechnology and nanotechnology networks. Ind Mark Manag. 2010;39(5):793–805.
7. Antivachis NA, Angelis VA. Network organizations: the question of governance. Procedia Soc Behav Sci. 2015;175:584–92.

8. Möller K, Halinen A. Managing business and innovation networks—From strategic nets to business fields and ecosystems. Ind Mark Manag. 2017;67:5–22.
9. Reypens C, Lievens A, Blazevic V. Hybrid orchestration in multi-stakeholder innovation networks: practices of mobilizing multiple, diverse stakeholders across organizational boundaries. Organ Stud. 2021;42(1):61–83.
10. Willmes R, Van Wessel M. The construction of (non-) responsibility in governance networks. SAGE Open. 2021;11(3):21582440211030620.
11. Câmara SF, Lima BB, Mota TLNG, Silva ALE, Padilha P. The management of innovation networks: possibilities of collaboration in light of game theory. Bus Manag Stud. 2018;4(2):24.
12. Perks H, Kowalkowski C, Witell L, Gustafsson A. Network orchestration for value platform development. Ind Mark Manag. 2017;67:106–21.
13. Brasil. Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq. Programa Instituto Nacional de Ciência e Tecnologia – INCT [Internet]. Brasília: CNPq; [cited 2023 Sep 15]. Available from: https://www.gov.br/cnpq/pt-br/acesso-a-informacao/acoes-e-programas/programas
14. Brasil. Academia Brasileira de Ciências – ABC. Primeiro Webinar ABC/CNPq – A contribuição dos INCTs para a sociedade [Internet]. 2022 Jun 5 [cited 2023 Nov 13]. Available from: https://www.abc.org.br/2022/06/05/1o-webinario-abc-cnpq-a-contribuicao-dos-incts-para-a-sociedade/
15. Vieira RP, Monteiro RLS, Pereira HB, De Andrade JB, Guarieiro LL. Redes de colaboração científica do INCT de Energia e Ambiente. Rev Virtual Quím. 2016;8(4):1234–48.
16. Oliveira R, Sanz L, Chaves R. Uma visão da ciência das redes sobre o Instituto Nacional de Ciência e Tecnologia em Informação Quântica (INCT-IQ). Rev Bras Ens Fís. 2022;44.
17. Da Costa Filho-Edes EG, Barbosa ACQ. Utilização de ferramentas estratégicas em redes de pesquisa que fomentam a inovação – o caso de um INCT. 2022.
18. Maia JMF, Ladeira AVGC, Cagnin CH, Villela ABDC. Análise de redes e FTA para uma avaliação estratégica dos Institutos Nacionais de Ciência e Tecnologia. Parcerias Estratégicas. 2015;20(40):101–23.
19. Ferreira VB, De Oliveira Villalobos AP, Moura MA. Rede de colaboração nos Institutos Nacionais de Ciência e Tecnologia de Nanotecnologia: a e-Science como protagonista do fazer científico. 2015.