



DIGITAL LIMITATIONS AND HOME OFFICE WORK IN REGIONAL INNOVATION ECOSYSTEMS: EVIDENCE FROM SOUTHERN RIO GRANDE DO SUL

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Abstract This study aims to identify the main limitations faced by innovation agents in building regional innovation environments under a home office work arrangement. To substantiate the analyses and discussions, a literature review was carried out on innovation ecosystems and digital limitations. Methodologically, this is a qualitative, descriptive and diagnostic study, conducted within the Regional Innovation System of Rio Grande do Sul, Brazil, with data collected through an online focus group. Content analysis was guided by a priori categories. The main results indicate: (i) difficulties in university–industry collaboration; (ii) challenges related to tools used for home office work; (iii) internet connection problems; (iv) limitations associated with the use of physical artefacts; (v) ergonomic issues; and (vi) implications of working in close proximity to family members. The discussion suggests the need for policies to mitigate these challenges, thereby supporting the work of innovation and technology managers (GITs) in consolidating the regional innovation ecosystem. In light of the ongoing digital transformation, the study offers practical contributions by highlighting the importance of jointly analysing digital, material, cognitive and behavioural limitations affecting public agents responsible for articulating regional innovation ecosystems.

Keywords: Digital limitations; regional innovation ecosystem; innovation management; digital transformation; remote work.

LIMITAÇÕES DIGITAIS E TRABALHO EM HOME OFFICE EM ECOSISTEMAS REGIONAIS DE INOVAÇÃO: EVIDÊNCIAS DO SUL DO RIO GRANDE DO SUL

Resumo O estudo tem por objetivo elencar as principais limitações dos agentes de inovação na construção de ambientes regionais de inovação em um formato de trabalho home office. Para consubstanciar as análises e discussões, realizou-se revisão de literatura sobre ecossistemas de inovação e limitações digitais. Quanto ao desenho metodológico, trata-se de pesquisa qualitativa, de caráter descritivo e diagnóstico, realizada no Sistema Regional de Inovação do Rio Grande do Sul, com coleta de dados por meio da técnica de grupo focal. A análise de conteúdo foi orientada por categorias a priori. Os principais resultados indicam: (i) dificuldades na interlocução universidade-empresa; (ii) desafios relacionados às ferramentas utilizadas para a execução do trabalho home office; (iii) problemas de conexão com a internet; (iv) limitações associadas ao uso de artefatos físicos; (v) aspectos ergonômicos do trabalho; e (vi) implicações de trabalhar próximo da família. As discussões sugerem a necessidade de proposição de políticas que mitiguem essas dificuldades, contribuindo para qualificar a atuação dos gestores de inovação e tecnologia (GITs) na consolidação do ecossistema regional de inovação. À luz do atual contexto de transformação digital, o estudo oferece contribuições práticas ao evidenciar a importância de analisar, de forma integrada, as limitações digitais, materiais, cognitivas e comportamentais na atuação de agentes públicos responsáveis pela articulação de ecossistemas regionais de inovação.

Palavras-chave: limitações digitais; ecossistema regional de inovação; gestão da inovação; transformação digital; trabalho remoto.

1. Introduction

Since the pioneering work of Schumpeter (1934), innovation has been understood as the

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engine of economic development, resulting from new combinations of existing resources. Throughout the 20th and early 21st centuries, entrepreneurship and innovation have consolidated themselves as central elements in explaining performance differences between firms, regions, and countries (DRUCKER, 2014; PEREIRA JUNIOR *et al.* , 2021b). Recent studies show that countries with higher intensity of innovation research, measured by indicators such as the Global Innovation Index, tend to be concentrated in the higher levels of human development (VUKOSZAVLYEV, 2019), reinforcing the centrality of innovation in the development of nations.

In the Brazilian context, Nagano, Stefanovitz, and Vick (2014) point to the high complexity of innovation management processes in organizations, marked by cultural and political constraints. The authors emphasize the role of organizational leadership in operationalizing innovation systems, as well as the need to investigate decision-making processes from a strategic perspective in order to understand the formation of the internal context and innovative performance. To understand this complexity, it is fundamental to recognize that innovation management requires frequent decisions and alignments that are directly affected by the cultural and political aspects of organizations. In this context, managerial action assumes a decisive role, since it is the leadership that, through its influence and strategic vision, operationalizes the innovation system. It is up to these leaders to shape internal processes and overcome natural resistance, ensuring that technological effort and new ideas effectively translate into performance improvements and adequate responses to the demands of the external environment (PEREIRA JUNIOR *et al.* , 2021b).

In parallel, the literature on innovation systems and ecosystems has been consolidating as a reference for understanding territorial development dynamics (LUNDVALL, 2007; SILVA; FERNANDES; SILVA, 2020; TURETTA; SANTOS; LABIAK JUNIOR, 2017). More recently, systematic review studies emphasize the role of higher education institutions (HEIs) as central actors in innovation and regional development ecosystems, expanding the so-called "third university mission" beyond the strictly technological logic, incorporating social and territorial dimensions (SCORTEGAGNA *et al.* , 2026).

Within the framework of Brazilian public policies, initiatives aimed at building regional innovation ecosystems, linking universities, companies, government, and civil society, have intensified. The INOVA RS program, from the Secretariat of Innovation, Science and Technology of Rio Grande do Sul (SICT/RS), fits into this agenda by structuring regional innovation ecosystems based on the coordinated action of the quadruple helix. However, the Covid-19 pandemic, declared in 2020, shifted a large part of these interactions to the digital



environment, imposing a new challenge: the construction and maintenance of innovation ecosystems in a *home office work context*.

The integration sought by programs like INOVA RS is based on the synergy of the quadruple helix of innovation, which advocates for collaborative work between academia, businesses, government, and society. The literature indicates that orchestrating these actors within a regional ecosystem reduces uncertainties in entrepreneurship and creates systemic cooperative relationships (LIMA *et al.*, 2025). When integrated, these helices promote not only technological innovation but also its entire social impact, driving intelligent specialization of the territory, fostering new businesses, and promoting sustainable economic development in the region (BONATO *et al.*, 2021).

Recent literature on universities and innovation highlights that, although higher education institutions (HEIs) are recognized as strategic actors in innovation ecosystems, their effective performance depends on adequate institutional, infrastructural, and relational conditions (SCORTEGAGNA *et al.*, 2026). In this sense, understanding the limitations experienced by public managers responsible for articulating these ecosystems while working *from home* is fundamental both for improving science, technology, and innovation (ST&I) policies and for the governance of the ecosystems themselves.

To investigate these difficulties imposed by remote work, the theoretical lens of Digital Limitations offers a suitable framework for analysis. The abrupt shift to the virtual environment has shown that the challenges of digital transformation go far beyond the simple adoption of tools (MENDONÇA *et al.*, 2024a; MENDONÇA *et al.*, 2024b). These limitations manifest themselves in a multidimensional way: through access barriers (material and social factors related to infrastructure), cognitive-informational limitations (lack of technological skills and knowledge), and behavioral constraints (such as resistance to use and difficulties in adaptation). Thus, identifying and overcoming these barriers becomes an essential step so that innovation governance is not paralyzed in exceptional scenarios (MENDONÇA *et al.*, 2024a; MENDONÇA *et al.*, 2024b; PEREIRA JUNIOR *et al.*, 2021a; PEREIRA JUNIOR *et al.*, 2021b).

This study, therefore, seeks to answer the following research question: what are the main limitations of innovation agents in building regional innovation environments in a *home office work format*? *The general objective is to list the main limitations of innovation agents in building regional innovation environments in a home office work format.*

The relevance of this research is justified by two main axes. From a managerial point of view, the findings can help public managers and other actors in ecosystem governance to



recognize recurring limitations in *remote work* and to formulate more effective institutional responses. From a scientific point of view, the study contributes by articulating the theory of digital constraints with the literature on regional innovation ecosystems and the third university mission, responding to recent calls for greater integration between these fields (SCORTEGAGNA *et al.*, 2026).

Following this introduction, section 2 discusses the theoretical framework on innovation ecosystems and digital limitations. Section 3 presents the methodological procedures. Section 4 contextualizes the INOVA RS program and the innovation ecosystem of the Southern Region of Rio Grande do Sul. Section 5 presents the results of the empirical research, followed by the discussion in section 6. Finally, section 7 presents the final considerations, policy proposals, and suggestions for future studies.

2. Theoretical framework: innovation ecosystems and digital constraints

This section presents the conceptual contributions that underpin the analysis undertaken. Initially, the concept of regional innovation ecosystems and systems is discussed, with emphasis on the role of higher education institutions and state action in coordinating science, technology, and innovation policies. Next, the notion of digital limitations is addressed, articulating its dimensions of access, cognitive-informational capabilities, and behavior within the context of *remote work*. The combination of these two theoretical axes allows us to understand how the material, cognitive, and behavioral conditions associated with the intensive use of digital technologies can strain the construction and governance of regional innovation ecosystems in crisis situations, such as that experienced during the Covid-19 pandemic.

2.1 Innovation Ecosystems

Silva, Fernandes and Silva (2020, p. 126) define an innovation system as “a set of different institutions that, when analyzed together, benefit and collaborate with each other to generate the development of innovation capacity in a given locality, segment, region or country”. Lundvall (2007) highlights that the analysis of national innovation systems involves, among other aspects, what occurs within firms in terms of competency building, forms of competition and cooperation, networks and interactions with the knowledge structure, as well as the specificities of educational systems and institutional regimes.

Azevedo (2016) emphasizes that the main function of an innovation system is to seek innovative processes: to develop, disseminate, and utilize innovations. Among the central



activities of this system, the author highlights the provision of R&D, the development of skills, the formation of new markets, the development of new fields of innovation, networking, the creation and change of institutions, and the financing and support of innovation.

National innovation systems can unfold into regional innovation systems (RIS). Borges, Cario, and Zimmermann (2020) argue that RIS share elements with the national system, involving organizations and institutions, interactive innovative search processes, technological learning mechanisms, development strategies, public policies, financial and technological flows, among others.

Garcia (2021) draws attention to the importance of spatial concentration and geographical proximity in regional systems, highlighting that, more than transportation costs, access to specific information mediated by face-to-face contact is important. The concentration of skilled workers, the mobility of human resources, and local networks reinforce the capacity for the generation, circulation, and recombination of knowledge.

The role of the State in building and coordinating innovation systems is widely recognized (LUNDVALL, 2007; SANTOS, 2014). Santos (2014) demonstrates that the State intervenes through macroeconomic, educational, R&D policies, strengthening social capital, and supporting technological change, being a central actor in promoting national skills and coordinating *catching strategies. technological up*. More recent studies reinforce this understanding by showing that HEIs have come to occupy a strategic position on the S&T agenda, becoming central actors in the construction of regional innovation ecosystems and in territorial development (CALDARELLI et al., 2015; SCORTEGAGNA et al., 2026).

In this context, the triple helix model—university, business, and government—and its extensions to the quadruple helix, with the inclusion of civil society, constitute relevant analytical frameworks (ETZKOWITZ and LEYDESDORFF, 2000; CARAYANNIS and CAMPBELL, 2009; LEMOS, 2013). The literature on entrepreneurial universities and the third mission indicates that higher education institutions (HEIs) have been assuming roles in knowledge transfer, spin-off generation, and participation in regional innovation policies (SCORTEGAGNA et al., 2026).

Lemos (2013) highlights that policies to stimulate regional economic clusters, academic spin-offs, and patenting and licensing activities have been used to intensify university-industry interactions. Azevedo (2016) emphasizes that these interactions depend on long-term investments and a historical trajectory marked by financial arrangements, the creation of institutions, interaction mechanisms, and the building of trust relationships. The difficulties largely stem from the absence of consolidated standards and the internal fragmentation of



universities.

In the case of the present study, it is important to understand how these dynamics of innovation ecosystems, strongly anchored in face-to-face interactions and contacts (GARCIA, 2021), were strained by the need for remote articulation due to the Covid-19 pandemic, especially from the perspective of public managers involved in a state program structured to operate in a face-to-face format.

2.2 Digital Limitations

The theory of planned behavior (TPB), proposed by Ajzen (1991), argues that attitudes, subjective norms, and perceived behavioral control influence intention and, under certain conditions, the transformation of that intention into effective behavior. Based on this lens, Bellini, Giebelen, and Casali (2010) propose the concept of digital limitations, structured in three dimensions: access limitations, cognitive-informational limitations, and behavioral limitations.

Access limitations refer to social and material difficulties in accessing information and communication technologies (ICTs), including digital exclusion, inadequate hardware and software, ergonomic problems, and limitations in connectivity infrastructure. Cognitive-informational limitations concern deficiencies in digital skills for searching, selecting, processing, and applying information made available by ICTs, stemming from multiple factors (neurological aspects, education, life trajectory). Behavioral limitations, in turn, consist of the difficulty in fully applying already acquired digital skills, ranging from psychological blocks to the use of ICTs to their excessive use (BELLINI, GIEBELEN and CASALI, 2010).

Recent research, conducted in the context of working *from home* during the Covid-19 pandemic, deepens the understanding of these limitations in work environments. Pereira Junior and Novello (2021) mapped ninety digital limitations experienced by teachers, organized into the three dimensions proposed by Bellini et al. (2010). In a complementary study, Pereira Junior et al. (2021b) analyzed the potential and challenges of teachers working *from home*, highlighting limitations related to technological devices, home infrastructure, work-life balance, and impacts on physical and mental health.

These studies suggest that digital limitations are not exclusive to the education sector, but cross different professions in *home office work contexts*. In the case of innovation and technology managers linked to INOVA RS, such limitations take on particular relevance, as they can directly affect the ability to articulate regional innovation ecosystems, university-business interaction, and the performance of the third university mission in specific territorial contexts



(SCORTEGAGNA *et al.* , 2026).

2.3. The International Debate on Digital Limits, Teleworking and Management in the Public Sector

With the sudden arrival of teleworking in public administration, it is clear that digital limitations did not occur by chance, but are part of a global challenge known in the market as the telework divide . *This* forced shift to remote work ended up exacerbating existing differences, bringing new barriers to the daily routines of public servants. Consequently, this shows us that access to digital tools and the adaptation process for each person vary greatly according to the profile and characteristics of each individual (KIM, 2023). In Italy, for example, although mandatory teleworking was a fundamental tool in facing the pandemic, it also revealed the practical and material problems of the public sector. Given this, data indicates that more than 60% of public servants had to use their own money to buy equipment and set up an adequate infrastructure at home to continue their services (CAPECCHI and CAPUTO, 2022).

To fully understand these material and structural barriers, the international debate categorizes digital exclusion into three progressive levels: physical access to infrastructure, digital skills, and the appropriation or purposeful use of technology (SEBERINI, NOUR and TOROVSKA, 2025). Studies focused on remote workers in South Korea highlight that socioeconomic status not only impacts basic access but is also a determining factor in the diversity of appropriation and use of ICTs. Thus, the absence of adequate corporate infrastructure not only hinders the first level of inclusion but also limits the employee's ability to extract productive results from the digital ecosystem, triggering direct effects on the cognitive and behavioral dimensions of work (SEBERINI, NOUR and TOROVSKA, 2025).

In cognitive and behavioral dimensions, the fragmented use of multiple tools without prior training acts as a strong trigger for *technostress* – the mental overload generated by the inability to cope with the demands of organizational information systems (SEBERINI, NOUR and TOROVSKA, 2025). This burnout directly impacts knowledge management practices, since teleworking alters the dynamics of knowledge acquisition, sharing, and application, generating even greater challenges in traditional cultures that depend on face-to-face interactions, as observed in Japanese management:

The impact of teleworking on knowledge sharing is complex. While teleworking can facilitate knowledge sharing through digital communication tools, it can also hinder the spontaneous and informal knowledge exchanges that occur in face-to-face environments. The effectiveness of knowledge sharing in teleworking depends significantly on the organization's communication infrastructure and employees' familiarity with digital tools (WATANABE, 2026, free translation).



In addition, research conducted in the Canadian public sector demonstrates that overload, coupled with a lack of autonomy and distance from colleagues, can generate what is called alienation at work, a state of severe disconnection from the function and the organizational team, as Doberstein and Charbonneau (2022) point out.

To mitigate these limitations, Organizational Support Theory (OST) reinforces that the performance and well-being of employees depend on how much they perceive that the institution values and supports them in a tangible way (KIM, 2023). International evidence indicates that best management practices for telework include granting greater autonomy, establishing good channels for interdependent tasks, and refraining from micromanagement, as shown in the study by Doberstein and Charbonneau (2022).

[...] revealed seven key implications for management practice in organizations that utilize telework, which can be tested in a context of forced mass telework, precipitated by the COVID-19 pandemic: (a) granting autonomy to individuals and avoiding micromanagement; (b) conveying a sense of trust to employees so that they perform their duties adequately at home; (c) creating social support networks among employees; (d) establishing good communication channels for task interdependence; (e) promoting flexibility regarding working hours; (f) coordinating online work activities; and (g) providing information on mentoring and career development [...] (DOBERSTEIN and CHARBONNEAU, 2022, p. 507, free translation).

Furthermore, the quality of virtual communication acts as an essential resource that, when combined with diverse skills in the use of ICTs, helps workers to deal more effectively with the merging of the corporate and family environments, maintaining high levels of cognitive and affective well-being (IHM, KIM and LEE, 2024). The articulation of this international panorama highlights that the role of innovation managers in the articulation of remote regional ecosystems demands structured support that goes far beyond simple internet access.

The sustainable success of teleworking and innovation networks requires building inclusive work environments through social dialogue, institutional provision of infrastructure, standardization of processes, and continuous investment in digital skills (SEBERINI, NOUR and TOROVSKA, 2025). Without these institutional guarantees, operational costs and stress are transferred to the individual, weakening talent retention strategies, information governance, and ultimately, the State's own capacity to innovate resiliently (KIM, 2023).

3 Methodological Procedures

Regarding its purpose, the research is classified as diagnostic, as it seeks to identify and clarify problems in a specific environment (ROESCH *et al.*, 2015). From the point of view of its approach, it is qualitative research, since it seeks to understand in depth the meanings attributed by the subjects to the phenomena investigated (SEVERINO, 2017).



3.1 Data collection

The data collection technique chosen was the focus group, in an online format. According to Morgan (1997), the focus group collects data through group interactions around topics proposed by the researcher, constituting an intermediate technique between participant observation and in-depth interviews. Veiga and Gondim (2001) highlight its potential for understanding processes of constructing perceptions, attitudes, and social representations.

The literature does not establish a rigid number of participants, varying according to the complexity of the topic and the level of knowledge of the subjects (ROCHA, FERREIRA and SILVA, 2012). In this study, a focus group was conducted with three innovation and technology managers (ITGs) from SICT/RS, responsible for the Southern Region of the INOVA RS program.

The focus group was held on November 23, 2021, via the SICT/RS online meeting platform. The session was recorded with the participants' consent, and the content was transcribed in a denaturalized manner, seeking to approximate standard written language (NASCIMENTO and STEINBRUCH, 2019).

The participants' profile is presented in Table 1.

Table 1 - Profile of respondents

ID	Education / Qualifications	Time spent working as a GIT at SICT/RS
GIT 1	Master's degree in Administration; Specialization in Business Management and Bachelor's degree in Production Engineering	Approximately 2 years
GIT 2	PhD and Master's degrees in Plant Health; Bachelor's and Licentiate degrees in Biological Sciences.	Approximately 2 years
GIT 3	Specialization in Project Management; Specialization in Business Management; Bachelor's Degree in Civil Engineering; and Bachelor's Degree in Engineering Edile – Architettura .	Approximately 1 year

Source: Prepared by the authors.

Although the focus group allowed for a deeper understanding of managers' perceptions regarding the limitations experienced in working *from home*, the study is recognized as limited by the small number of participants (three Innovation Working Groups) and the focus on only one of the eight regions of INOVA RS. In qualitative research, the emphasis is on the density and interpretative coherence of the data, rather than on statistical representativeness (MORGAN, 1997; SEVERINO, 2017); however, such choices imply that the findings should not be generalized to the entire Regional Innovation System of Rio Grande do Sul, and should be understood as a contextualized case study. In this sense, the results indicate trends and relevant aspects of the experience of the Innovation Working Groups in the Southern Region, opening



space for future investigations that broaden the geographical scope and diversity of participants.

3.2 Data Analysis

The data were analyzed using content analysis, as per Bardin (2011), which allows inferences from systematic message description procedures, identifying explicit and latent content. A priori categories were used, defined based on the literature on digital limitations (BELLINI; GIEBELEN; CASALI, 2010; PEREIRA JUNIOR; NOVELLO, 2021; PEREIRA JUNIOR *et al.*, 2021b):

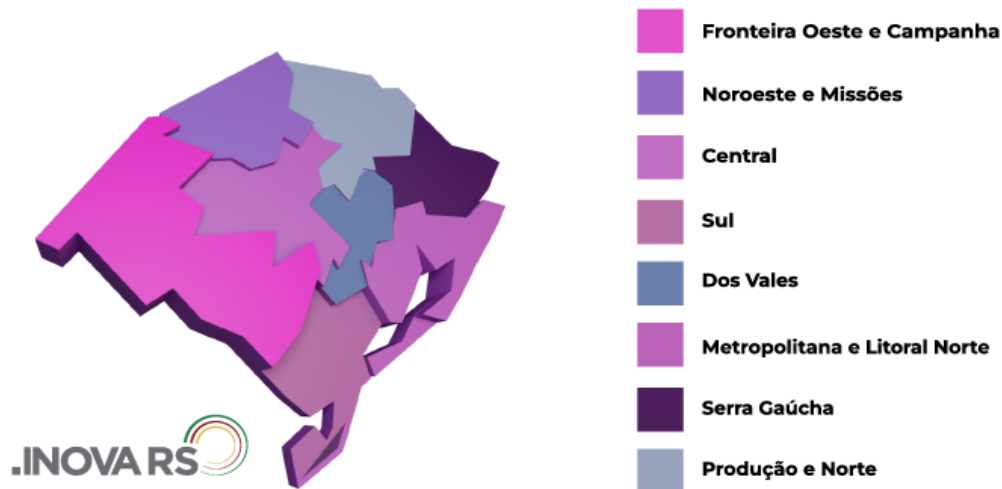
- a) access limitation;
- b) cognitive-informational limitation;
- c) behavioral limitation.

In the coding process, excerpts from the GITs' speeches were related to theoretical categories, allowing the identification of subtopics such as: university-business interaction, use of digital work tools, internet connection problems, physical artifacts, ergonomic aspects, and work-family balance.

4 INOVA RS and the Innovation Ecosystem

The INOVA RS program integrates the Rio Grande do Sul government's strategy to place the state on the global innovation map, through the consolidation of eight regional innovation ecosystems: Metropolitan and North Coast; South; Western Border and Campanha; Central; Valleys; Northwest and Missões; Production and North; and Serra and Hortênsias (SICT, 2020) (Figure 1, below). Actors of the quadruple helix—organized civil society, the business sector, educational and research institutions, and government—are articulated with a view to defining local priorities, formulating visions for the future, and developing strategic projects.

Figure 1- Map of Rio Grande do Sul, by INOVA RS



Source: <https://sict.rs.gov.br/conheca-inova-rs>. Accessed on May 19, 2026.

In the Southern Region (Figure 2, below), the subject of this study, important assets stand out: the presence of federal universities and institutes (FURG, UFPel, UCPel, IFSul, IFRS), technology parks (Pelotas Technological Park and Oceantec), incubators, NGOs supporting entrepreneurship, and a significant number of startups (SICT, 2020). This arrangement is similar to the description of innovation ecosystems found in the international literature, in which HEIs assume the role of "central nodes" in the articulation of networks, knowledge transfer, and support for innovation (CALDARELLI *et al.*, 2015; SCORTEGAGNA *et al.*, 2026).

Figure 2- Southern Region of Rio Grande do Sul, according to INOVA RS



Source: <https://inova.rs.gov.br/sul>. Accessed on May 19, 2026.

The southern region is composed of the following municipalities, local innovation



ecosystems, and regional development systems:

Table 2 - Municipalities, local innovation ecosystems and regional development systems of the Southern Region of Rio Grande do Sul in INOVA RS

MUNICIPALITIES	Amaral Ferrador, Arroio do Padre, Arroio Grande, Camaquã, Canguçu, Capão do Leão, Cerrito, Chuí, Herval, Jaguarão, Morro Redondo, Pedras Altas, Pedro Osório, Pelotas, Pinheiro Machado, Piratini, Rio Grande, Santa Vitória do Palmar, Santana da Boa Vista, São José do Norte, São Lourenço do Sul, Tavares and Turuçu .
Local Innovation Ecosystems	Candy Valley - Innovation Ecosystem of Southern Rio Grande do Sul Great Innovation Pact - Rio Grande Innovation Ecosystem inPel - Pelotas Innovation Ecosystem Oceanvalley - Rio Grande Innovation Community Ynov Camaquã - Movement for Innovation in Camaquã
REGIONAL DEVELOPMENT SYSTEMS	Local Maritime Productive Arrangement Local Productive Arrangement for Health Technological Modernization Hub of the Southern Coast - Fishing Sector

Source: <https://inova.rs.gov.br/sul>. Accessed on May 19, 2026.

INOVA RS operates through a governance structure that involves a strategic committee, a technical committee, and the so-called "INOVA RS Table," integrating local and regional leaders (SICT, 2021). To support this structure, SICT/RS selected and trained three GITs per region, responsible for coordinating stakeholders, promoting projects, and monitoring the implementation of innovation agendas, assuming a role as *knowledge brokers* between universities, companies, government, and society, in line with what international literature describes for third-mission contexts and innovation ecosystems (RANGA; ETZKOWITZ, 2013; SCORTEGAGNA *et al.*, 2026).

The implementation of INOVA RS began in 2019, with a design originally conceived for in-person interactions. However, the Covid-19 pandemic rapidly shifted these interactions to a *home office environment*, forcing innovation teams and other ecosystem actors to articulate complex innovation networks using digital tools, under diverse conditions of infrastructure, skills, and home contexts.

5 Results

Based on the content analysis of the GITs' speeches, the following categories of limitations in working *from home emerged*: (i) difficulties in university-company communication; (ii) tools used to perform work *from home*; (iii) internet connection problems; (iv) use of physical artifacts; (v) ergonomic aspects of the work; and (vi) working close to family.



5.1 University-Industry Dialogue

The GITs (Interinstitutional Working Groups) see their role as essential in fostering closer ties between universities and companies in the Southern Region, but emphasize that this interaction still heavily depends on active mobilization efforts.

“We have to chase after the actors, this is not yet a process that occurs dynamically [...] Today, INOVA RS Southern Region really needs the support of the GITs and coordinators to bring them together and pursue these stakeholders.” (GIT 1)

“It’s very difficult to connect with some companies, because many still have a more closed vision. [...] Regarding open innovation, we are trying to work to break down this barrier. It’s something we have to pursue with companies, yes.” (GIT 2)

Despite the challenges, the GITs report signs of maturing relationships, with emerging partnerships and greater engagement from universities, startups, and municipalities:

“I really see that we took the first step, and now we’re starting to see that things are truly moving forward, without our help.” (GIT 3)

“Today we have a good relationship with the entire S system, with the universities, especially UFPel and FURG [...]. We have a group of startups well connected with INOVA RS, young companies that make all the difference for the development of the region.” (GIT 2)

Home office work tools

GITs report the use of multiple digital tools in everyday life :

“We use Webex for meetings, OneDrive for organization, sometimes we also use Google Meet, because Webex is heavy, so sometimes it crashes [...] and WhatsApp for communication.” (GIT 3; GIT 1)

WhatsApp, in particular, emerges as a central communication tool, although it combines personal and professional spheres:

“I don’t delete anything on WhatsApp, so I can go back and look there. [...] I think what gets in the way is being both professional and personal. [...] It would be worse if there was another tool, because we would have to divide ourselves between yet another one.” (GIT 1)

The GITs team states that they did not receive formal training on the use of most tools, except for initial support for Webex. Learning occurred largely through trial and error and mutual support.

“We didn’t have any training, we just made do as we went, through trial and error. Whoever knew more helped the other, and that’s how we managed.” (GIT 2)



5.3 Internet connection problems

Connection problems are reported as occasional, but significant:

“There are frequent power outages, so there are times when I have to switch to 4G, sometimes I ask: 'girls, give me support because the power went out'. And sometimes the internet connection is very unstable.” (GIT 2)

The existence of three GITs in the region is highlighted as a mitigating factor:

“In our region there are three people, so if one can't make it, there will be two others. It's less likely that someone will be unable to participate due to internet problems.” (GIT 1)

5.4 Use of physical artifacts

The GIT teams use notebooks provided by SICT/RS, but report recurring failures:

"This year it's already needed assistance three times. [...] We don't have the best tools in the world, but we do what we can." (GIT 1)

Furthermore, personal cell phones are widely used as work tools, including for meetings and communication.

"My cell phone, I've always prioritized having a better cell phone, because I know it's also a work tool." (GIT 1)

5.5 Ergonomic aspects and working close to the family

The statements highlight ergonomic and organizational challenges in the home environment:

“I have a place where I could spend most of my time alone, but the internet isn't great, so I'm always looking for spots with better internet. [...] It's not an environment like an office, which is fully equipped.” (GIT 1)

The presence of young children appears as a source of interruptions, but also as a positive aspect of cohabitation:

“I have two children [...]. I have a proper office, but sometimes, even with the room closed, I'm surprised by little hands opening the door, running after the camera.” (GIT 2)

“I liked being able to be close, but I can also be professional. [...] Today I see my children much more; before, I would go out and not even see them wake up.” (GIT 2)

In order to synthesize the empirical evidence presented, Table 3 consolidates the main limitations identified in the *home office work* of GITs, relating them to the dimensions of digital



limitations proposed by Bellini, Giebelen and Casali (2010).

Table 3 - Summary of the limitations experienced by GITs in *home office work* and respective dimensions of digital limitations.

Limitation identified	Brief description	Predominant digital limitation dimension*
Difficulties in university-business communication	Need for active mobilization of stakeholders; weak culture of cooperation on the part of companies; interactions lacking spontaneity.	Predominantly behavioral (attitudes, norms, and engagement)
Challenges in using multiple digital tools for working <i>from home</i> .	Simultaneous use of Webex, Google Meet, OneDrive, and WhatsApp, without standardization and with little formal training.	Cognitive-informational (efficient use of ICTs) and behavioral
Internet connection problems	Signal fluctuations, power outages, the need to use 4G, and support from colleagues to ensure participation in meetings.	Access (connectivity infrastructure)
Weaknesses in the use of physical devices (laptops and cell phones)	Institutional laptops with recurring malfunctions; intensive use of personal devices as a work tool.	Access (hardware and technical support)
Ergonomic issues in the home environment	Makeshift workspaces; inadequate furniture; the need to move around the house in search of a better signal.	Access (material conditions for the use of ICTs)
Impacts of working close to family (especially young children)	Frequent interruptions during meetings; difficulty maintaining concentration; ambivalence between overload and the benefits of social interaction.	Behavioral (self-management, work-family boundaries, well-being)

Source: Prepared by the authors.

6. Discussion

The results show that GITs experience limitations that align with the literature on innovation ecosystems, university-industry interaction, and digital limitations, as well as with recent studies on *home office work* in higher education and innovation contexts (PEREIRA JUNIOR; NOVELLO, 2021; PEREIRA JUNIOR *et al.*, 2021b; SCORTEGAGNA *et al.*, 2026).

6.1 University-business interaction and regional ecosystems

The difficulties reported in university-business interaction—the need to "chase after" stakeholders, and a business culture that is not very open to cooperation—converge with studies that point to project uncertainties, bureaucracy, intellectual property disputes, and knowledge asymmetries as barriers to cooperation (SCHAEFFER *et al.*, 2015). Lemos (2013) warns of the risk of unilateral interactions, in which only one side is effectively engaged.

At the same time, reports of emerging partnerships, closer ties with startups, and active participation from universities and municipalities align with the literature on entrepreneurial



universities and the third mission, which highlights higher education institutions as agents of regional development, particularly in peripheral regions (CALDARELLI *et al.* , 2015; SCORTEGAGNA *et al.* , 2026). In this sense, the role of GITs as mediators between the actors of the quadruple helix is similar to the role of *knowledge brokers* described by Ranga and Etzkowitz (2013) in European innovation ecosystems.

To overcome these barriers of disarticulation and weak connections that reduce regional competitiveness, the consolidation of this mediated network becomes indispensable. The literature shows that the synergistic integration of the actors of the quadruple helix (academia, businesses, government, and society) is structurally necessary because no actor in the ecosystem possesses, in isolation, all the resources required to develop innovations. Thus, the orchestration promoted by universities and facilitating agents, such as the significant role of Innovation and Technology Managers (ITMs), directly impacts knowledge management and reduces uncertainty in entrepreneurship, establishing cooperative relationships (LIMA *et al.* , 2025). When implemented, this collaborative approach transcends mere technological innovation, resulting in practical developments for regional development, such as the promotion of new businesses, job creation, and improvements in the local quality of life (BONATO *et al.* , 2021).

The consolidation of this network mediated by GITs and the overcoming of barriers to articulation in the quadruple helix find support in the international debate on public management in telework. As Watanabe (2026) points out, although the digital environment can facilitate knowledge sharing, it imposes severe challenges by hindering the spontaneous and informal exchanges that naturally occur in face-to-face spaces. In the context of regional ecosystems, where traditional cultures often depend on face-to-face interactions to generate mutual trust, the effectiveness of knowledge management becomes critically dependent on the communication infrastructure and the agents' familiarity with the tools. Therefore, the role of GITs in coordinating online work activities and establishing good communication channels for the interdependence of tasks, aligning with two of the seven managerial implications proposed by Doberstein and Charbonneau (2022), becomes a structural requirement to mitigate distance and ensure that the orchestration of knowledge flows and generates resilient innovation in the region.

6.2 Digital tools and cognitive and behavioral limitations

From an empirical standpoint, the combined use of Webex, Google Meet, OneDrive, and WhatsApp, as reported by the GITs (Global Interaction Teams), demonstrates the expansion of the repertoire of digital tools mobilized in the management of the ecosystem. OneDrive appears as a central solution for organizing files and administrative activities, while Webex and Google



Meet are used for meetings with different audiences, including due to bandwidth restrictions and connection stability. WhatsApp, in turn, emerges as an everyday communication tool, including for recording and later retrieving information, even though it mixes professional and personal interactions. Managers report that, except for initial support for using Webex, there was no systematic training for adopting these resources, so mastery of the tools occurred through trial and error, peer support, and autonomous learning.

In light of the literature, these findings align with studies that highlight the centrality of cloud platforms for supporting administrative and pedagogical activities in remote contexts (LIMA; GLORIA JÚNIOR, 2021; PERNENCAR *et al.*, 2021; SANTIAGO; PAES, 2021), as well as the increasing use of videoconferencing tools for teaching purposes, institutional meetings, and procedural acts (SILVA, 2021; TEIXEIRA; NASCIMENTO, 2021). In particular, the ambivalent role of WhatsApp, simultaneously facilitating communication and potentially causing information overload, is similar to what was observed in research with teachers during the pandemic (PEREIRA JUNIOR; NOVELLO, 2021; PEREIRA JUNIOR *et al.*, 2021b; NOVELLO *et al.*, 2021).

When interpreted in light of the digital limitations proposed by Bellini, Giebelen, and Casali (2010), the reports from the GITs suggest a predominance of cognitive-informational and behavioral limitations in this dimension. The absence of structured training for the use of platforms tends to reinforce internal inequalities in the use of ICTs and to induce improvised practices, in line with evidence of underutilization of systems in contexts where learning is entirely delegated to the user (PEREIRA JUNIOR; SCHROEDER; DOLCI, 2019). Furthermore, the use of multiple channels, without institutional standardization, can contribute to the blurring of boundaries between work and private life, intensify expectations of permanent availability, and encourage the adoption of "communication shortcuts" that weaken information governance in the ecosystem (NOVELLO *et al.*, 2021; ALVES *et al.*, 2025).

This predominance of cognitive-informational and behavioral limitations observed in IT support teams directly reflects the vulnerability scenario described by Seberini, Nour, and Torovska (2025). According to the authors, the fragmented and simultaneous use of multiple technological tools, without adequate prior training support, acts as a strong trigger for technostress, mentally overloading the worker in the face of the demands of information systems. Without continuous investment in digital training and without the standardization of processes by the State, the mastery of the platforms is entirely delegated to the user, which deepens the disparities in technological appropriation. This lack of institutional support not only induces improvised practices and the adoption of communication shortcuts, but also limits the



manager's ability to extract productive and strategic results from the digital ecosystem, compromising information governance.

6.3 Infrastructure, physical artifacts and access limitations

From an empirical standpoint, GITs report that internet connection problems, power fluctuations, and recurring failures in institutional laptops interfere with remote work. The need to resort to 4G in situations of power outages or signal instability, as well as relying on colleagues when unable to fully participate in meetings, appears as a strategy for mitigating these difficulties. The testimonies also indicate intensive use of personal devices, especially cell phones, as work tools, both for participating in meetings and for daily communication with ecosystem stakeholders.

Interpreted using the typology of Bellini *et al.* (2010), these reports highlight access limitations associated with connectivity infrastructure, hardware, and available technical support. As identified in studies on teachers working from home during the pandemic, a significant portion of infrastructure costs is transferred to individuals, both in terms of internet access and the equipment used (PEREIRA JUNIOR; NOVELLO, 2021; PEREIRA JUNIOR *et al.*, 2021b; ARAÚJO *et al.*, 2021). This dynamic is similar to the phenomenon described by Leite and Pereira Junior (2021) when discussing the use of personal devices for academic purposes, suggesting a kind of "domestic BYOD" that, ultimately, can lead to precarious working conditions.

Literature warns that when organizations do not clearly assume responsibility for providing and maintaining adequate infrastructure, workers tend to resort to improvised solutions, incurring additional financial costs and risks (NOVELLO *et al.*, 2021). In the context analyzed, the use of personal equipment and home internet connections, coupled with the absence of more robust technical support, can compromise the stability of coordination activities during critical moments in the ecosystem and contribute to the emergence of ergonomic and occupational health problems, as research on intensified remote work in the context of health crises points out (PEREIRA JUNIOR; NOVELLO, 2021; PEREIRA JUNIOR *et al.*, 2021b).

The transfer of infrastructure costs and technical improvisation reported by the GITs find an exact parallel in the international literature on the public sector. The empirical reality of these managers resembles the data from Italy presented by Capecchi and Caputo (2022), where more than 60% of public servants had to financially bear the costs of home equipment and infrastructure to maintain the continuity of state services. In light of the three-level typology of digital exclusion (Seberini, Nour, and Torovska, 2025), it is evident that precariousness at the



first level—physical access to adequate infrastructure and hardware—compromises progress to subsequent levels of skill and appropriation. As Kim (2023) summarizes, when the institution fails to provide the necessary structured support and material inputs, operational costs are transferred directly to the individual, weakening institutional resilience and the very capacity for public governance.

6.4 Ergonomics, family and well-being

Reports about improvised spaces, the search for better internet signal within the home, the lack of adequate furniture, and frequent interruptions from family members are similar to the findings of Novello *et al.* (2021) and Araújo *et al.* (2021), which highlight ergonomic challenges, intensified work, and tensions in domestic coexistence during prolonged *home office work regimes*.

At the same time, GITs also point to positive aspects, such as greater family time and the possibility of reconciling parental and professional responsibilities, which reinforces the ambivalent nature of *home office work* already identified in the literature (NOVELLO *et al.*, 2021). In the specific context of innovation ecosystem management, such subjective factors can influence engagement, availability for meetings at different times, and the ability to respond quickly to demands from the various actors in the quadruple helix.

This same flexibility that expands the availability for interaction within the ecosystem carries, however, the risk of hyperconnectivity and the excessive extension of the workday. The literature warns that the absence of physical boundaries between the corporate space and the home significantly hinders the separation between professional duties and personal demands, transforming this reconciliation into a daily and constant challenge (SANTOS *et al.*, 2023). Without strictly predetermined schedules, a culture of expectation for immediate responses is fostered, frequently mediated by instant messaging applications, which induces professionals to remain connected for much longer (NOVELLO *et al.*, 2021; PEREIRA JUNIOR and NOVELLO, 2021). Consequently, this overlapping of spheres requires continuous negotiations in order to prevent the increased physical presence at home from turning into overload, friction, or a feeling of invasion of privacy experienced by other residents (NOVELLO *et al.*, 2021; PEREIRA JUNIOR and MATTEI, 2021).

Ultimately, the ambivalence between flexible hours and the overload generated by hyperconnectivity evokes the precepts of organizational support theory. According to Kim (2023), the well-being and performance of remote workers are conditioned by how much they perceive that the institution values and supports them tangibly, going far beyond mere internet



access. To neutralize the risks of the merging of professional and family spheres, Ihm, Kim, and Lee (2024) reinforce that the quality of virtual communication acts as an indispensable protective resource, helping the worker to preserve their levels of cognitive and affective well-being. Addressing this telework *divide therefore* requires management practices based on granting autonomy, establishing social support networks, and rejecting micromanagement (DOBERSTEIN; CHARBONNEAU, 2022). Without this inclusive environment built through social dialogue, the unregulated overlapping of spheres and the distancing of the team can culminate in a state of alienation at work, weakening the engagement of managers in the articulation of the ecosystem.

7. Final Considerations

This study aimed to analyze the limitations experienced by innovation and technology managers at SICT/RS, working in the INOVA RS program, in building a regional innovation ecosystem under a home office work regime, during the Covid-19 pandemic, in the Southern Region of Rio Grande do Sul.

The results revealed a set of digital limitations that span access, cognitive, and behavioral dimensions, expressed in: (i) difficulties in university-business interaction; (ii) challenges in using multiple digital tools; (iii) internet connection problems; (iv) weaknesses in the use of physical artifacts; (v) ergonomic issues; and (vi) impacts of working close to family. These limitations not only reproduce but also specify, for the context of regional innovation ecosystems, findings from previous research conducted with teachers and other workers in home office arrangements (PEREIRA JUNIOR; NOVELLO, 2021; PEREIRA JUNIOR et al., 2021b; NOVELLO et al., 2021).

Given that these findings stem from a focus group with three managers working in only one of the eight regions of the INOVA RS program, the policy and management proposals presented below should be understood as recommendations situated within that specific context. Their potential extension to other regions of the program, or to ecosystems with distinct configurations, requires further investigations that explore the particularities of each territory.

In conclusion, based on the experience of the Southern Region, the following policy and management guidelines are proposed:

a) University-business dialogue: strengthening institutional cooperation mechanisms, reducing time asymmetries between the deliberative logics of the public sector and the urgencies of the business sector (LEMOS, 2013; SCHAEFFER et al., 2015). This may include framework



agreements, more agile governance arrangements, and permanent channels of dialogue with business associations and startups.

b) Digital tools: adopt a minimum standardization policy for official tools for meetings and project management, reducing dispersion and uncertainty about communication channels. Consider, for the regional context analyzed, the acquisition of an institutional project management system that articulates information about meetings, deliverables, and indicators.

c) Connectivity: recognize that the responsibility for the connectivity infrastructure necessary for working from home should not fall exclusively on employees. Within the Southern Region, evaluate measures such as supporting broadband plans, providing data chips, or creating institutional spaces with guaranteed internet access for occasional use by the GITs (Gentils, Interoperabilities, and Technology Offices).

d) Physical artifacts: ensure preventive and corrective maintenance of the supplied equipment, with prompt replacement in case of recurring failures. Consider, in the context investigated, the provision of corporate cell phones, with plans suitable for use in ecosystem coordination activities.

e) Ergonomics and work-life balance: consider offering ergonomic guidance, psychosocial support and, where possible, providing shared in-person workspaces, respecting health regulations. These spaces can help reduce ergonomic and connectivity limitations during critical moments of the work of the coordinator in the region analyzed.

From a theoretical standpoint, the study contributes by articulating the framework of regional innovation ecosystems and the literature on the third university mission through the lens of digital limitations, highlighting how the context of home office work strains and reconfigures the performance of public managers in the construction of ecosystems. By drawing parallels between the INOVA RS experience and international discussions on universities, innovation, and regional development (SCORTEGAGNA *et al.* , 2026), it reinforces the importance of understanding the material, cognitive, and behavioral dimensions that mediate the performance of these agents in the digital environment.

One limitation is that the research only covered one of the eight regions of INOVA RS, with a focus group composed of three managers. Future studies could expand the analysis to the other regions, make comparisons between territories, and incorporate other governance actors (representatives of higher education institutions, companies, civil society), as well as explore mixed methods that integrate qualitative data and quantitative performance indicators of the ecosystems.



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