Researcher management and cooperation: challenges in Brazilian research organizations from the perspective of microfoundations

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Abstract
In this work, we explore the dynamics of microfoundations dimensions (individuals, processes and structures) of research organizations (ROs) in order to diagnose the challenges faced by researcher management in Brazilian ROs and improve cooperative actions. To this end, analytical variables were defined from the theoretical fields of management (people and microfoundations) and research-industry cooperation, and applied in three exploratory-descriptive case studies. The results show that the effectiveness of research-industry cooperation depends on paradigm shift and long-term actions, such as the implementation of a collaborative organizational culture and the prioritization of innovative governance. Furthermore, the development of these capacities is hampered by the low maturity of career development processes, structural and financial-budgetary constraints. This research contributes to theoretical development, establishing constructs from the ROs specificities and proposing initial relationships among the analytical variables structured. For practice, we highlight the organizational diagnosis and actions for a better cooperative performance of ROs.

Keywords: researcher management; microfoundations; research-industry cooperation; research organizations (ROs); challenges

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Introduction

Although the research-industry relationship is a recurring theme in discussions and innovation policies in Brazil aimed at innovative productive development (Brito Cruz, 2019; Salles-Filho *et al*., 2021), market and institutional deficiencies are still considered obstacles to the establishment of a more effective cooperation (Fischer, Schaeffer & Phaiffer, 2018; Salles-Filho *et al*., 2021; Silva & Sartori, 2022). Some scholars (such as Oliveira and Bonacelli (2019), Ribeiro, Salles-Filho and Bin (2015), Ronsom and Amaral (2017)) argue that the institutional strengthening of Brazilian ROs through the improvement of routines and collective capacities in research, development and innovation (R&D&I) is a mechanism for changes in the above scenario.

In line with this perspective, this article focuses on the management of researchers, which is a direct path to the development of ROs competencies so as to favor their performance (Coccia & Rolfo, 2013; Adegbile, Sarpong & Kolade, 2021). For this purpose, we used as theoretical lenses people management approaches in R&D&I environments, especially as a promoter of both commitment and collaboration (Zhou, Hong & Liu, 2013), as well as the microfoundations dimensions proposed by Felin *et al*. (2012) (i.e., individuals, processes and structure).

The area of people management has a significant impact on the performance of individuals, organizations and their innovative processes (Zhou, Hong & Liu, 2013). In the field of R&D&I, attention should be given not only to the importance of individuals (Brazilian Association of Technical Standards [ABNT], 2011; Taggar, 2002), but also to social interactions, the means and the organizational context in which they occur (ABNT, 2011; Collins & Smith, 2006) for the achievement of complex processes associated with its conduction.

Different theories have been applied to outline factors that contribute to and/or challenge the success of research-industry cooperation (Albats, Bogers & Podmetina, 2020). However, the literature tends to overlook the operational peculiarities and institutional dynamics that interfere with the results of these cooperations, especially in the case of institutions with relative specificities and instability such as ROs, where individual factors and other fundamentals of organizational levels play very important roles in the success of partnerships with companies (Adegbile, Sarpong & Kolade, 2021).

In the Brazilian literature, although people development is listed among the variables sensitive to the context of action of ROs that require continuous management (Center for Management and Strategic Studies [CGEE], 2010; Salles-Filho & Bonacelli, 2010), there are few studies addressing this aspect. It is also worth considering the specific dynamics of ROs and the peculiarities of their managerial and cooperative processes, which differ depending on the geographic and cultural contexts in which they are inserted (Salles-Filho *et al*., 2021).

In view of the above, the conduction of research aiming to diagnose researcher management in Brazilian ROs based on microfoundations parameters consistent with the specificities of these organizations is a necessary step to better understand it. Such parameters can support the development of fronts of action and the strengthening of cooperation so as to minimize inconsistencies and maximize benefits, resulting in better operations and allowing more effective interactions. Therefore, the aim of this work is to contribute to some answers to the following questions: How does researcher management in Brazilian ROs affect the establishment of research-industry cooperation? How can microfoundations be used to investigate researcher management in ROs and which are the challenges involved in the establishment of these cooperations?

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The next sections explore the organizational and behavioral variables that have challenged the management routines of ROs researchers toward the establishment of research-industry cooperation. Such aspects, consolidated and structured from specificities reported in the literature on ROs, define the analytical variables used as parameters for the empirical studies.

Thus, the case studies, which were conducted in units whose missions are focused on the development of cooperation in R&D&I of three Brazilian ROs in the state of São Paulo (SP), namely, University of São Paulo (USP), Federal University of São Carlos (UFSCar) and a research institute linked to the Secretariat of Economic Development, Science, Technology and Innovation, aimed to verify the application of previously defined theoretical constructs in order to both characterize the microfoundations that interfere with organization and coordination of people and investigate their challenges. The operationalization of these studies is exposed in the Methodological framework section.

The Results section describes the main characteristics of the analytical variables raised empirically, while the Discussion section addresses the challenges resulting from comparisons with the proposed theoretical intersections. Final considerations are presented in the last section, together with the original contributions of this article.

ROs and challenges to cooperation from the perspective of microfoundations

Challenges and obstacles to research-industry cooperation have been broadly addressed in the literature, being well established that they arise from complexities inherent to R&D&I and the institutional and cultural differences of the stakeholders (Albats, Bogers & Podmetina, 2020; Salles-Filho *et al*., 2021), such as the limitations resulting from the administrative and managerial differences experienced (Salles-Filho *et al*., 2021; Silva & Sartori, 2022). However, studies on the operational dynamics of these cooperations, particularly the factors of microfoundations dimensions (i.e., individuals, procedures and structures) (Felin *et al*., 2012) that contribute to shaping the collective outcomes, are still scarce (Albats, Bogers & Podmetina, 2020; Adegbile, Sarpong & Kolade, 2021; Salles-Filho *et al*., 2021).

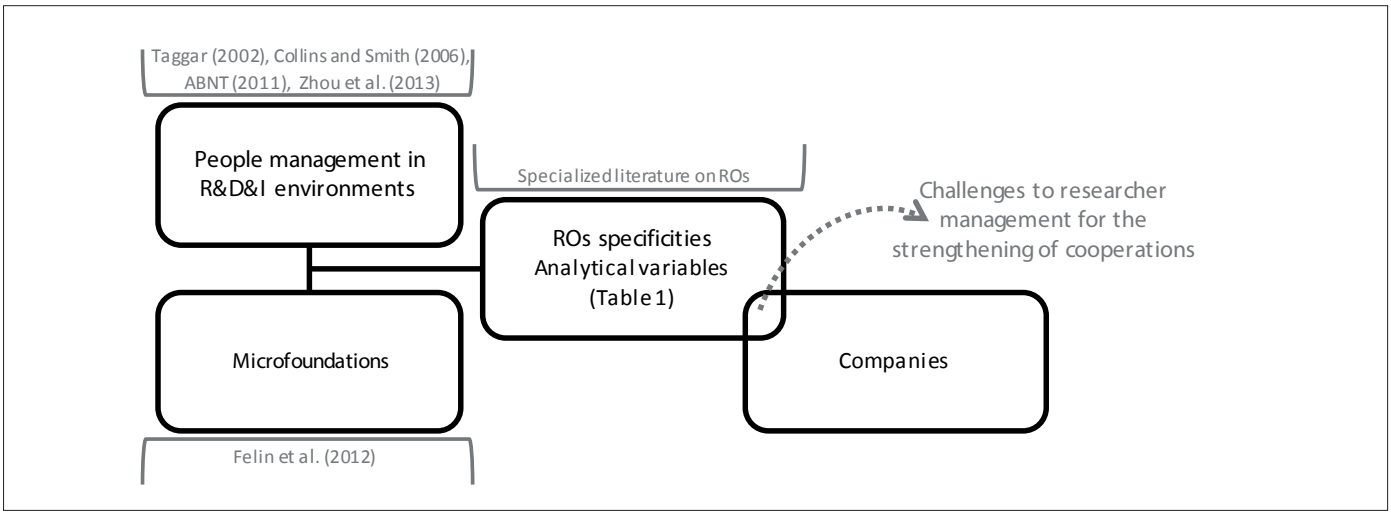
Addressing the heterogeneity and complexities of ROs can contribute to a better understanding of the problems that emerge in research-industry interactions. This study seeks to offer a comprehension of the managerial dynamics of the individuals responsible for bringing novelties to ROs, the means available to organize and coordinate them, and the behaviors that interfere with the development of capacities for cooperation based on the microfoundations of routines and organizational capacities compiled from the fields of management by Felin *et al*. (2012).

A focus is given to the diagnosis of challenges to people management processes in ROs, which are also dependent on the organizational context (structure) and individuals (ABNT, 2011; Chiavenato, 2014; Collins & Smith, 2006; Taggar, 2002). Although people management is recognized as relevant to the success of R&D&I (Coccia & Rolfo, 2013; Collins & Smith, 2006; Weiss *et al*., 2019; Zhou, Hong & Liu, 2013), it is poorly established in the literature (Weiss *et al*., 2019), especially when the context explored is the reality of ROs (Coccia & Rolfo, 2013).

In addition to the contingent and situational nature of people management (Chiavenato, 2014), differences regarding companies, such as the articulation of different actors and agents (researchers, graduate students, technical and administrative support professionals, funding and support agencies, other ROs and business partners) (Adler, Elmquist & Norrgren, 2009), public ownership, resource scarcity, lack of specific skills (Poli *et al*., 2018) and relative dependence on political control are seen as particular challenges to people management in ROs, thus requiring a close look at these organizations.

Figure 1 illustrates the theoretical constructs of this research. Analytical variables correspond to microfoundations aspects derived from ROs specificities, according to the multiple and distinct research streams presented in the sequence.

Figure 1: Theoretical framework (Authors, 2022)



Organizational structure: hierarchy and flexibility

The organizational structure may not only restrict the behavior of individuals and their development, but also allow efficient information processing, knowledge acquisition and sharing, coordination, integration, and therefore cooperative action (Felin *et al*., 2012). Studies have shown how administrative structures contribute to the effectiveness of ROs (Leme *et al*., 2015; Oliveira & Bonacelli, 2019), contrasting with the discussions about interference in autonomy and flexibility to carry out R&D&I based on *organizational and/or normative models* of the organizations under study (Adegbile, Sarpong & Kolade, 2021; Barlatier & Giannopoulou, 2011; Boardman & Ponomariov, 2014; CGEE, 2010; Ribeiro *et al*., 2015; ; Salles-Filho & Bonacelli, 2010).

The definition of *decision-making structures* (delegation and organizational functions) that help formalize partnerships with companies, such as the requirements for ROs participating in innovation financing programs, can guarantee efficient allocation of public resources as well as effective communication between actors and different decision-making levels (i.e., top management and research and administrative staff) (Leme *et al*., 2015; Cheah & Ho, 2020).

The literature indicates that rigid and hierarchical structures, such as those found in universities, do not allow autonomy, which can create problems for an effective coordination (Adegbile, Sarpong & Kolade, 2021). In line with this idea, Barlatier and Giannopoulou (2011) propose the adaptation of less formalized and adaptive (organic) organizational models for a greater combination of research knowledge. Studies focused on the Brazilian reality reflect on how normative restrictions of ROs impose low autonomy and flexibility to design actions aimed at institutional development, for instance, the design of people management processes (i.e., recruitment, hiring, career plan development and talent retention) (CGEE, 2010; Ribeiro *et al*., 2015; Salles-Filho & Bonacelli, 2010), bringing negative repercussions to the innovative results of such organizations.

The aforementioned contextual aspects referring to the organizational structure, along with the individuals' characteristics (next section), are important building blocks for understanding the capabilities of ROs and the implications for people management for the establishment of research-industry cooperations.

Researchers: collaboration and leadership

The different human and social capitals of ROs, i.e., skills, knowledge, experiences and cognitive abilities, influence coordination of people and consequently cooperative processes in R&D&I. Behavioral challenges permeate *values for the creation of shared knowledge*, whose idiosyncratic characteristics (highly qualified and socially distinct individuals with a high level of creativity, curiosity and autonomy, all fundamental for the execution of persevering and independent intellectual work) can generate conflicts, for example, the prioritization of individual initiatives to the detriment of collective priorities (Bin & Salles-Filho, 2012), and hinder the necessary coordination and control to achieve effective collective results (Bin & Salles-Filho, 2012; Sapienza, 2004).

The lack of managerial (hard skills), behavioral (soft skills such as collaboration and creativity among others) (Barlatier & Giannopoulou, 2011; Koppinen, Lammasniemi & Kalliokoski, 2010) and business research skills (researchers' ideas and proposals can bring views not targeted for commercial exploitation) (Koppinen, Lammasniemi & Kalliokoski, 2010) presents itself as a cognitive limitation. As argued by Adegbile, Sarpong & Kolade (2021), an important facet for the development of competencies and cooperation of the human capital of ROs is *experiential learning*, which is acquired through knowledge exchange with partners.

When the focus is on scientific managers, different skills and competencies are addressed, together with the most appropriate leadership profile for conducting R&D&I processes. Studies have shown that individual "champions" as catalyst leaders and members of research groups affect cooperative behavior and performance (Adegbile, Sarpong & Kolade, 2021; Biasini, 2012; Casati & Genet, 2014; Coccia & Rolfo, 2013; Sapienza, 2005; Schwartzman, 2008).

Salles-Filho and Bonacelli (2010) argue that, although technical-scientific leadership is a necessary condition, it is not sufficient for the management and achievement of ROs missions. On the other hand, when carrying out a survey about the experiences of researchers from Europe, Asia and the United States, Sapienza (2005) identified that good leaders are often described as caring and compassionate, in contrast to the expected description of technically competent. Likewise, Biasini (2012) and Poli *et al*. (2018) also highlighted the importance of leadership soft skills for the creation of a collaborative organizational climate in ROs.

The capability of researchers to mobilize resources for their research is also positively linked to their initiatives to cooperate with companies (Adegbile, Sarpong & Kolade, 2021; Casati & Genet, 2014). "Champion" leaders (Adegbile, Sarpong & Kolade, 2021) act as catalysts (Coccia & Rolfo, 2013), basing themselves on their experiences and understandings of academia, government and business to mediate knowledge, resources and contacts, expanding research agendas and creating new opportunities in a strategic and proactive way (Casati & Genet, 2014).

Considering that interactions among individuals, processes and resources critically shape routines and abilities (Felin *et al*., 2012), the next section addresses how people management processes affect (or can affect) the performance of RO professionals toward cooperation, as well as the counterpoints of their implementation.

People management: interactions and challenges

Some studies demonstrate how formal people management practices can support the integration of different organizational elements, shaping the collective interest to achieve common goals (such as the generation of knowledge and technologies for companies). The practices identified are those typically found in the classic human resources literature (summarized in Table 1).

Loyarte-Lopez *et al*. (2018) associated the implementation of a *career development system* in ROs from Europe with a greater achievement of several goals, such as technology transfer activities and scientific production, in addition to a greater satisfaction of researchers. Nevertheless, the lack of career plans in R&D&I can hinder or frustrate individual creativity, leading to a low performance of RO researchers (Chiesa & Fratini, 2009).

Among the recommendations for people management and development in ROs, Coccia and Rolfo (2013) suggest the design of flexible *reward systems* proportional to the performance of researchers as a way to reduce brain drain, sunk cost and loss of tacit knowledge accumulated over time. However, these organizations face difficulties in identifying merit criteria related to R&D&I besides a lack of financial resources (Poli *et al*., 2018).

On the other hand, when linked to organizational performance appraisal systems, *individual assessment programs* can provide not only transparency to stakeholders, but also improvements in technological results (Munkongsujarit & Srivannaboon, 2017; Poli *et al*. 2018). Employee *training and development (T&D)* practices can help researchers create synergies, develop multiple skills (Barlatier & Giannopoulou, 2011; Hilkenmeier, Fechtelpeter & Decius, 2021; Koppinen, Lammasniemi & Kalliokoski, 2010; Sapienza 2005), such as leadership and technical-scientific and business skills, and consequently achieve scientific and commercial goals (Chiesa & Frattini, 2009).

Besides these practices, the use of *integrative technologies* can structure social interaction between stakeholders, act as a repository of knowledge on business partners, transactions and commitments, and innovate internal processes (Adegbile, Sarpong & Kolade, 2021; Barlatier & Giannopoulou, 2011), resulting in coordination without intervention (Barlatier & Giannopoulou, 2011).

The creation of a *stimulating work environment (ecology)* with clear objectives, collaborative teams and fluent communication among others can also increase the performance of ROs (Chiesa & Frattini, 2009). *Informal aspects of coordination* including trust and culture are also identified as factors that influence the development of cooperations in R&D&I (Adegbile, Sarpong & Kolade, 2021).

All in all, the abovementioned strategies mentioned reveal the complex organizational context of ROs for the establishment of intra- and inter-organizational collaborations and the definition of a considerable set of (non-exhaustive) variables that interfere with people management and hinder the occurrence of these interactions. Table 1 summarizes these variables according to the three microfoundations dimensions.

Table 1: Analytical variables for the characterization of researcher management dynamics

Organizational Structure: hierarchy and flexibility	Researchers: collaboration and leadership	People management: interactions and challenges
Decision-making structure; Organizational/normative models	Values for collaboration; Experiences and learning; Leadership profile	Career development (Career Plan, Compensation, Performance Appraisal, T&D); Ecology; Integrative technologies; Informal aspects of coordination

The validity of the structured variables (Table 1) was empirically verified based on the methodological resources described below.

Methodological framework

This research follows a qualitative approach and explores in depth three exploratory- descriptive cases (Voss, Tsikriktsis, & Frohlich, 2002) in order to better understand the people management phenomenon in ROs. It also has a descriptive nature, as it seeks to outline the characteristics and challenges of such phenomenon for the establishment of research-industry cooperation.

With the aim of developing theory (instead of generating theory), we designed a theoretical framework (Figure 1) that consists of articulated theories from the fields of management and research-industry cooperation as well as analytical variables (summarized in Table 1) whose validity was verified empirically. The results of the empirical studies also contribute to the construction of initial propositions about relationships among the proposed theoretical variables.

In this work, ROs comprise institutes and centers (university or not) created to generate impact through knowledge and technology transfer to companies. Thus, representative Brazilian cases (Yin, 2018) of ROs designed to cooperate with companies were the criteria adopted for the choice of the three studied units. It is worth mentioning that the state of São Paulo (SP) is a reference, as it ranks indices such as innovative capacity of Brazilian states and public investments in science and technology (Federation of Industries of the State of Ceará [FIEC], 2019).

The first study was conducted between the second and third trimesters of 2019 at the Optics and Photonics Research Center (CePOF), located at the São Carlos Institute of Physics (IFSC), USP, São Carlos, SP. Formalized in 2000, the center comprises 25 research laboratories and approximately 165 collaborators (internal and external). Its activities are focused on research about the transposition of physical boundaries, dissemination of science and technological innovation through multi- and interdisciplinary collaborations. These activities have involved a significant volume of extrabudgetary resources, particularly from innovation financing programs of the São Paulo Research Foundation (FAPESP), the Coordination for the Improvement of Higher Education Personnel (CAPES), the National Council for Scientific and Technological Development (CNPq), and the Brazilian

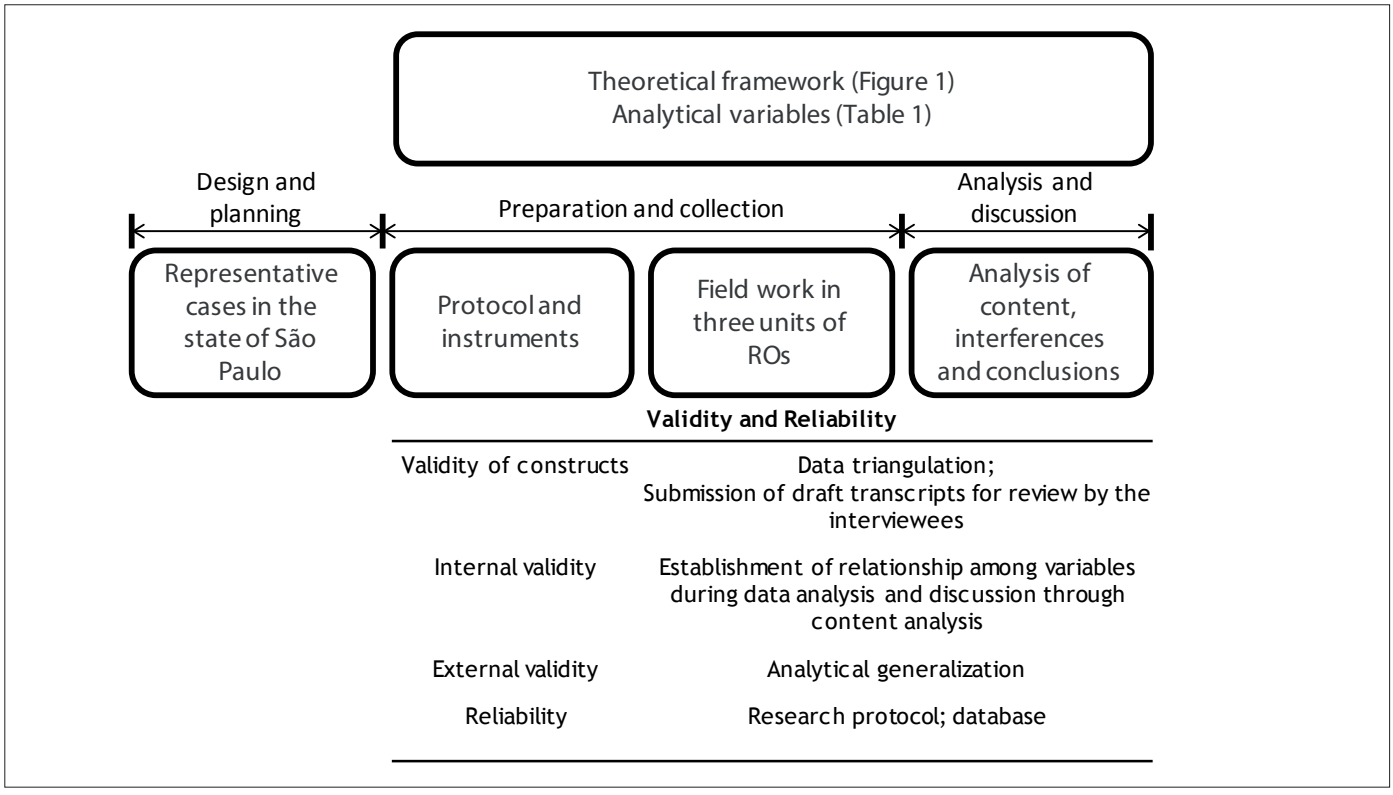
Industrial Research and Innovation Company (EMBRAPII). Technological projects are currently concentrated on the area of biophotonics and are carried out at the center's technological support laboratory.

The second and third studies were carried out between the last trimester of 2020 and the first months of 2021. The second study was conducted at the Center of Excellence for Research in Sustainable Chemistry (CERSusCem), located at the Department of Chemistry (DQ) of UFSCar, São Carlos, SP. This center was created in 2016 through a public-private partnership, having the multinational pharmaceutical company GlaxoSmithKline (GSK) as a private partner and FAPESP and four other ROs as public partners. The mission of the center is to develop high-impact research, promote education and disseminate science and innovation, with competencies focused on organic synthesis, especially on the principles of sustainable chemistry. Technology transfer to the productive sector is also an integral part and one of the main goals of the partnership proposal. CERSusCem consists of four laboratories located at UFSCar, in addition to those belonging to the partner ROs, and counts with the involvement of approximately 150 people.

The third study was performed at a research institute located in the municipality of São Paulo. It is a centenary public company that offers technological support to the public and private productive sectors. Its operating segments involve seven technological areas of concentration, namely, advanced materials, energy, cities and the environment, housing and buildings, digital technologies, bionanomanufacturing and metrology, translated into R&D&I projects, testing, analysis and calibration, technical advice and studies (consultancy), reference materials and educational activities. Data collection was performed in the area of bionanomanufacturing (ACT-Bionano), encompassing competencies for the development of biotechnological process scheduling (among others). ACT-Bionano has an infrastructure for multidisciplinary action since 2012, with six laboratories and approximately 150 collaborators. Being responsible for a considerable portion of revenue in R&D&I, ACT-Bionano also makes use of external public funding resources, such as those provided by EMBRAPII.

The operationalization of the case studies followed the set of activities and tools for data planning, collection, validation and reliability described by Yin (2018). The protocol adopted as an instrument to guide the study planning defined the interview script and the validity and reliability criteria. A summary of these criteria can be seen in Figure 2.

Figure 2: Case study method



After transcription and validation, the semi-structured interviews were used as the main source of evidence, so that even with the use of scripts composed of contemplative questions of the analytical variables summarized in Table 1 it was possible to collect complementary and relevant information, initially unstructured. The interviews were conducted online (with the exception of the first case, in which face-to-face interviews were carried out immediately before the pandemic, allowing the observation of the work dynamics) and lasted approximately sixty minutes each. Flexible data collection was adopted (Eisenhardt, 1989), alternating between collection and analysis.

Additional contacts (complementary interviews, phone calls and/or e-mail exchanges) were made to resolve unclarified and/or not initially discussed questions. The scripts were adapted to the interviewees' profiles.

Different professionals involved in R&D&I processes and coordination of people participated in the study, i.e., researchers, scientific managers and administrative employees. A total of 19 interviews were carried out, according to the following division: CePOF (Interviewees I_1 to I_8: three scientific managers including the general coordinator, two researchers, and three administrative managers); CERSusChem (Interviewees I_9 to I_{13}: three scientific managers including the director, one researcher and an administrative manager); ACT-Bionano (Interviewees I_{14} to I_{19}: two scientific managers including the director, one researcher, and three administrative managers including the financial and administrative directors).

Direct observations (in the case of CePOF) and analyses of documentation (management reports, master plans, policies and R&D&I funding notices, totaling 17 documents – D_1 to D_{17}), archival records (patent catalog, organizational charts and history of technological financing, totaling four records – R_1 to R_4) and institutional videos (nine media – V_1 to V_9) were used as secondary instruments in order to seek multiple collection mechanisms for the development of convergent lines of investigation (data triangulation), enabling information collection from different sources of evidence for the same phenomenon under study (Miguel & Sousa, 2012; Yin, 2018).

The set of validated transcripts, together with the information gathered from secondary sources, constituted the research database. The analyses were built from a general descriptive narrative followed by subsequent reductions that allowed to draw logical conclusions through interpretations based on systematized data (Miguel & Sousa, 2012). Categorical content analysis (Bardin, 2011; Miguel & Sousa, 2012) was adopted to map the challenges. The classification categories derived from the microfoundations dimensions were already known, that is, they were previously defined.

Results

The characterization of the dynamics of people coordination and organization is described for each case based on analytical variables (Table 1) and previously established theoretical constructs (Figure 1).

CePOF

The organizational structure of the center is composed of a committee of researcher managers (general coordinator and area coordinators) and professionals with managerial and administrative support functions. The authority structure for conducting technological research, which despite being centered on the general coordinator allows some technical-scientific autonomy to other coordinators and staffs, along with the existing structure of functions, reveals an organization of people established through divisions of work for the distribution of administrative and scientific knowledge without restricting R&D&I activities.

In practice, management activities informally undertaken by the administrative support staff and the difficulties in hiring support managers "due to both unavailability in the market and the restrictions of university financial resources" (I_2) evidence the formation of multifunctional teams that contribute to an interaction and agility in the execution of tasks – skills necessary for the development of collaborative projects. In the institutional scope, some interviewees revealed difficulties regarding the progress of processes under responsibilities of deliberative bodies of the university in which the center is inserted and the research support agencies.

Concerning the individual characteristics, it could be observed from the analysis of the performance of scientific managers that the management of activities related to industry cooperation is centralized on the general coordinator, who accumulates multiple functions (i.e., researcher, project manager, people manager and negotiator among others). The presence of an entrepreneurial profile (in business) is extensive to other scientific managers; however, it is clear that the general coordinator: i) is directly involved in the acquisition of extra-budgetary resources from different sources (as also demonstrated in documents and archival records); ii) is responsible for the commercialization of developed technologies, including the organization of workshops and various media in order to advertise the products developed through business partnerships; and iii) coordinates the transfer of scientific reputation to national and international networks.

Such characteristics, typical of "champion" leaders described in the literature (Adegbile, Sarpong & Kolade, 2021), greatly influence the collaborative and entrepreneurial organizational culture of the center, evidenced by the creation of startups and spin-offs, the volume of technological deliveries, the generation of patents and the cooperation between teams for the implementation of technological projects.

With respect to the basic processes of people management, one of the critical points raised by the researchers is the dissatisfaction with the recruitment model, which is based on temporary contracts and unattractive financial rewards: "If there is a professionalization [career position] of researchers, in my opinion, it could increase and facilitate the chances of technological development, as the researcher will be there for a long time" (I_5). As for the performance appraisal mechanisms, the general coordinator provides feedbacks to the researchers every six months and assesses their performance in the laboratories annually, "however, there is no formal assessment plan" (I_3). Existing reports, assessments and information systems follow the requirements of the funding programs in force.

In relation to T&D, except for participation in seminars and technical-scientific events, there is an absence of institutional mechanisms: "Each one is responsible for their own development process" (I_3); "There is a lack of it [training]" (I_5). In general, the professionals interviewed revealed themselves open to both T&D actions and the incorporation of management mechanisms to support laboratory and project routines. For the managers, although these aspects are not considered essential, contradictory reports point to opportunities for improvement:

If we formalize it [training] too much now, it can bring difficulties instead of helping (I_2); Specific project coordinators end up developing skills that shape their profiles in order to act as scientific leaders and project managers. [However,] project management occurs more as way to offer operational support rather than decision-making support [...]. Purchasing, business plan organization, team travel and so on still leave a lot to be desired (I_1).

In short, people management at the unit is characterized by the involvement of a small number of individuals in decision-making actions for the occurrence of research-industry cooperations, with emphasis on the general coordinator, who is responsible for articulating internal and external bodies, including his own direct involvement, to overcome university bureaucracies typically recognized in the literature. In addition to partial skepticism towards the professionalization of R&D&I, poorly structured career development processes which impact the motivation of some researchers interviewed indicate areas in which changes could contribute to the achievement of greater synergies.

CERSusChem

The formal structure of the center is similar to that of CePOF. In practice, the performance of the managerial support professionals is also restricted, with the researcher managers accumulating functions with the support of a secretary. With the creation of the center, a different view about the way of working could be achieved, such as the development of indicators to measure research-industry interactions, along with the acknowledgement of the importance of administrative management – although some contradictions were also reported: "Coordinating all actions is not a simple task. [However,] these [support] managers are not so much needed, a secretary is essential" (I_{10}); "[...] The centers should have a project manager" (I_9).

Concerning the decision-making structure, the director has authority to monitor and control goals, besides proposing interactive activities among members. However, according to the set of reports and results from the center it is possible to infer that there have been few changes in the researchers' work model, which occurs in an autonomous but decentralized way: "Each one does what they have always done" (I_{10}); "To each their own" (I_{12}). Internal collaborations, when present, tend to occur in the academic area, with restricted integration for research-industry cooperations.

As a result of the center structuring, there was the mapping of different competencies for the researchers associated with the public-private partnership, in addition to the definition of possible integrative activities in R&D&I. There was also an increase in demand and greater interactions with companies and spin-offs, including those with graduate entrepreneurs from the ICT (Scientific, Technological and Innovation Institution) headquarters, workshops with the industry, and more recently, EMBRAPII accreditation. Until the conclusion of this research, there was no record of technology transfer and patents.

Great technical-scientific competence associated with the delivery of high-impact research stands out as a predominant characteristic of the professionals. Tendencies to prioritize basic research, education and knowledge dissemination end up hindering the establishment of more structured actions for technological development in the short and medium terms, which may be responsible for the current difficulties in relation to (internal) network performance and market targeting. Such aspects are associated with the difficulties in establishing cooperation according to the researchers' profile (as identified by Bin & Salles-filho (2012), Koppinen, Lammasniemi & Kalliokoski (2010) and Sapienza (2004)), which can be corroborated by the reflections raised by some interviewees:

What is missing is this catalysis, the researcher-industry contact. It could be our initiative to establish a contact with them. [...] Obviously gathering researchers who are open to shaping themselves to the needs of companies (I_{11}); Indeed, we are very academic. There should be someone designated for this, but this creates conflict, [...] someone who has a market view (I_{12}).

With respect to the basic processes of people management, there are dissatisfactions with the institutional bureaucracy and the funding agencies in relation to hiring scholarship holders. There has been agility in the processes resulting from the work of the support foundation and the research cooperative efforts of the unit. The model used by funding agencies to evaluate researchers was also considered to be limiting the development of technological cooperative activities: "The people [scholarship holders] continue to be monitored and judged much more by their academic publication history than by their deliveries of solved problems [of companies]" (I_9).

There is a lack of systematic assessment and T&D processes aimed at professionals of the center. Exceptions include the promotion of webinars, with a predominance of technical-scientific approaches (of the 31 webinars published on the unit's website, only two addressed topics about the development of other skills, e.g., entrepreneurship and innovation), and assessments arising from funding programs, such as the elaboration of reports and organization of annual meetings for general performance appraisal.

In summary, the three microfoundations dimensions are characterized by: i) the predominance of structural obstacles typical of the university context, with an accumulation of administrative and managerial functions by scientific managers, which is also influenced by a partial skepticism towards the professionalization of the R&D&I; ii) the lack of catalytic leadership (Coccia & Rolfo, 2013) for the centralization of cooperative actions; iii) poorly structured and/or inadequate career development processes and technological resources for the development of competencies necessary for a better performance in technological research and research-industry cooperation, including the need to develop business competencies and soft skills for the integration of research teams.

ACT-Bionano

There is a hierarchical organizational structure in the center composed of a director and coordinators (heads) of laboratories, whose

functions and authority are focused on the management and monitoring of operational routines. The unit also has managerial and administrative operational support structures, being common the occurrence of interactions and collaborations with universities and other ROs when there are no internal competencies designed for meeting technological demands: "We connect outside partners from other areas that we do not master and manage to include them in the execution of projects" (I_{14}).

The coordination of R&D&I projects takes place autonomously, with the technical manager being responsible for conducting and fulfilling the work plan defined together with the company, in a format similar to the matrix management of projects, but without a formal definition of assignments. The hierarchical structure of the center was generally described as not interfering with the execution of projects. Professionals and administrative support structures contribute to a macro management, being identified as essential to the success of R&D&I projects, in congruence with the literature. The conduction of laboratory activities and interactions, on the other hand, was reported as dependent on the profile of the technical manager and the teams involved.

It was also possible to observe the occurrence of integrated and multidisciplinary projects, which tend to take place according to the scope of the theme and the interest in development, being favored by behavioral components, such as affinity, accumulated history of interactions and trust: "Although there is a culture [of interactions], I still see the effectiveness of the occurrence of the mechanism very dependent on people" (I_{15}). The interviewees highlighted the role of the executive director of operations in establishing intense coordination among the ACT directors to share R&D&I demands, in addition to structuring work processes and strategies in a collaborative way.

The technical-scientific competencies for the successful translation of R&D&I demands are evident, represented in the volumes of deliveries and generation of patents, together with the presence of a collaborative culture, including the synergy between support professionals and researchers. Researchers with multiple skills are highly desired for the occupation of strategic positions: "Researchers who run the IPT manage to integrate the managerial/negotiation part in a smarter way, without much resistance on how to position themselves in the market" (I_{19}).

Although openness to the development of behavioral and cultural aspects is perceived, this topic is not fully implemented. Institutional discussions provided by the new chain of command (since 2019) seek to prioritize it through the adoption of the following strategies: restructuring of the career and compensation plans, assessments based on individual indicators for eventual progressions, and job rotation of managerial positions in order to "[...] prepare more leaders and provide more interesting horizons for those who are within the institute" (I_{18}).

Regarding the recruitment process, temporary employment through support foundations has been an alternative for employability in view of financial and budgetary fluctuations. There is an individual development plan as an assessment and development model (which has not been applied since 2014) and a model of key performance indicators and goals (such as technical publications, participation in scientific events, number of patent applications and contribution margin of projects to R&D&I revenue) as a tool to evaluate individual and collective results.

The institute currently has some T&D programs; however, they are offered on a reduced scale, as they are dependent on its financial situation. Although training courses for managers are also an initiative of the institute, the opinion of one of the interviewees points to the need for improvements: "At some point the institute planned to offer some training [in management]. I would say that maybe it is still not enough compared to what we really need" (I_{15}).

In conclusion, the context in which collaborative research is carried out is characterized by: the presence of a robust structure to support the accomplishment of cooperative R&D&I projects without making the activities rigid; the necessity for R&D&I-oriented professionals and acknowledgment of their relevance, which can even become a source of income for the economic sustainability of the institution's operations; behaviors and values for collaboration, which can be improved; not fully structured career development programs and awareness of their importance as a performance improvement factor.

Discussion

According to the results and considering the specificities of the three cases, the interviewees' statements, together with other evidences collected, indicate a set of challenges from the microfoundations perspective (Table 2) linked, in order of relative importance, to the individuals' wish to participate in collaborative projects, followed by the (bureaucratic) context in which ROs are inserted and the way the institution organizes and coordinates the R&D&I activities.

Table 2: Challenges to researcher management

Microfoundation	Challenge	Source of main evidence (secondary)	% (by total number of interviewees)
Organizational Structure	Governance with an emphasis on innovation	I_1, I_2, I_4, I_7, I_9, I_{10}, I_{11}, I_{13}, I_{15} (D_2, D_3, D_{13})	42%
Researchers	Development of values for collaboration	I_3, I_5, I_8, I_9, I_{12}, I_{13}, I_{14}, I_{15}, I_{17}, I_{19} (D_6, D_7, R_1, V_1 to V_5)	53%
	Professionalization of research	I_1, I_2, I_3, I_9, I_{10}, I_{11}, I_{13}, I_{17}, I_{19}	47%
Processes and Interactions (People Management)	Sustainability of career development plans	I_3, I_5, I_6, I_{10}, I_{14}, I_{18}, I_{19} (D_5, D_{15})	37%
	Strengthening of supporting technologies/ environments	I_1, I_3, I_5, I_6, I_{15}, I_{19} (D_{14}, D_{15})	32%

Concerning the microfoundation Organizational Structure, the different degrees of organizational maturity and internal arrangements for making research-industry cooperations feasible in the three units highlight the institutional heterogeneity of Brazilian ROs (CGGE, 2010), even though belonging to the same regional economic and political context (i.e., São Paulo state).

Although university research centers are consolidated as more flexible structures of university organization (Adegbile, Sarpong & Kolade, 2021), the CePOF and CERSusChem results show well-known factors such as the lack of autonomy to carry out the main activities of the center due to the institutional decision-making hierarchy. On the contrary, the hierarchical model of deliberative bodies of ACT-Bionano, in which macro-organizational guidelines are systematized to achieve satisfactory results in R&D&I, does not seem to affect partnerships.

Also in contrast to other structural variables of ACT-Bionano, the low effectiveness of support bodies (such as a support foundation, as is the case of CePOF) and failures in the provision of support professionals to university centers, according to current institutional counterparts required by R&D&I funding actions, confirm the considerations made by Oliveira and Bonacelli (2019) that the search for greater efficiency and impactful results from Brazilian ROs is directly related to reduced bureaucracy and the maturity of their governance structure. Such aspects are considered structural constraints to the effective stimulation of cooperative actions with companies (Felin *et al*., 2012).

In addition to changes related to the structural context of project execution, the results reinforce the role of behavioral characteristics of managers and teams in carrying out multidisciplinary and cooperative R&D&I actions. While autonomy is present in the conduction of research and the management of scientific knowledge (which is in agreement with studies developed by Barlatier and Giannopoulou (2011) and Boardman and Ponomariov (2014), for example, on the adequacy of less formalized structures for carrying out RO operations), the lack of coordination ends up negatively influencing the integrated execution of technological projects, as is the case of CERSusChem.

The typical case of predominance of academic culture at CERSusChem reveals the importance of counterbalancing other skills in addition to the technical-scientific ones (which were found to be present in the three units). Emphasis should be given to the profile of the occupants of executive positions at CePOF and ACT-Bionano. By accumulating multiple skills and showing extensive experience in research-industry cooperation, these executive managers reinforce the authoritative role of the main researcher for the integration of the different expectations of actors in a research institute and the establishment of mutual trust (Adler, Elmquist & Norrgren, 2009; Boardman & Ponomariov, 2014) and innovative culture, especially in the case of CePOF, in which several interactions are directly promoted by the general coordinator.

Considering that different competencies and skills are required to achieve satisfactory results in R&D&I, the challenge here explored involves the structuring of a culture associated with the development of values, competencies, skills and experiences for collaborative performance in order that R&D&I be understood as a collective action. For a better consolidation of human integrations, another obstacle to be overcome is the skepticism toward the professionalization of the R&D&I staff, such as the lack of prioritization of managerial training for researchers and the lack of awareness of the importance of support managers, which leads to the concentration and overload of decision-making actions on a reduced number of professionals (as are the cases of CePOF and CERSusChem).

Such resistance (in the cases of CePOF and CERSusChem) may be associated with the belief that R&D&I uncertainties and unpredictability cannot be controlled (Biasini, 2012; Casati & Genet, 2014; Sapienza, 2004), being a recurrent conflict in the literature. As discussed by Casati and Genet (2014), more than establishing formal training for developing scientific management, it is necessary to search for a new perspective on scientific production, allowing the adoption of new practices and learning.

It is worth mentioning that the development of these capacities and other foundations of organizational cooperation, including the deserved authority of those in charge (power with legitimacy) and mutual trust, occurs essentially in the long term, partly depending on informal daily collaborations (Sennett, 2019). Such capacities are hampered by the low maturity of career development processes for researchers, such as the temporary condition of professionals due to short- to medium-term scholarships and the difficulties imposed by structural and financial-budgetary matters in permanently hiring professionals in the three units studied.

Additionally, there is a lack of prioritization of actions for the development of training courses and assessments focused on R&D&I, which reveals, together with the previous points, the need to establish regional and/or national policies that contribute to the leveling of governance in the scope of R&D&I in Brazilian ROs, as well as to develop actions and programs that guarantee the sustainability of career development. It should be highlighted that more advanced innovation systems have prioritized career development in ROs through regulatory frameworks that improve their efficiency, with repercussions in the researchers' satisfaction (Loyarte-Lopez *et al*. 2018), representing an important tool for performance improvement in R&D&I (Chiesa & Fratini, 2009).

Since changes in people management processes tend to be hampered by regulatory and financial limitations, we indicate as initial avenues for the promotion of changes the spaces of managerial autonomy available in ROs (Ribeiro *et al*., 2015) in order that strategies aimed at meeting organizational (results in RD&I) and individual expectations be adopted. The suggested strategic actions for the three units studied (that can also be applied in ROs in general to improve cooperative performance) are:

i) to enable the creation of institutional programs to train deficient topics, such as business skills (in order to obtain financial advantages),

and managerial and soft skills either through existing training schools or through the intermediation of support foundations and/or innovation agencies (to achieve economies of scale and agility);

ii) to instigate partnerships with professional associations and funding agencies to provide training and promote experience exchange in research management (Oliveira; & Bonacelli, 2019);

iii) to encourage the exchange of researchers in partner companies to achieve experiential learning and establish long-term partnerships (Hilkenmeier, Fechtelpeter & Decius, 2021);

iv) to encourage benchmarking (as suggested by Casat and Genet (2014)) with other ROs for the incorporation of good practices for management and competency development. Examples include the mentoring program of ACT-Bionano, which was considered to be very relevant for the professional development of the interviewees and low-cost, and the model of good practices for the management and development of the workforce mentioned by Loyarte-Lopez *et al.* (2018);

v) to create assessments and collective reward mechanisms to measure the progress of collaborative activities in R&D&I (refer to the indicators suggested by Brito Cruz (2019), some of which already monitored by the ACT-Bionano performance measurement system, with the purpose of granting research resources and/or (extra) scores for career advancement goals);

vi) following Sapienza's (2005) recommendations, to promote curricular changes to offer the training of multiple skills during research teaching (in undergraduate and graduate courses) allied to the development of more prepared profiles for scientific leadership and technological cooperation.

Lastly, even with less evidence, we highlight the importance of considering the available spaces for interactions, including workshops and physical environments that promote innovation, as well as information systems as mechanisms to guarantee effective cooperation in R&D&I and elucidate the role of funding agencies as promoters of improvements of these variables, as clearly seen in the cases of CePOF and CERSusChem.

From the considerations raised, two general propositions can be outlined. First, the capabilities for establishing cooperation are directly dependent both on the multiple skills and experiences of individuals involved in research operations and on the level of institutional governance with an innovative focus. Second, innovative governance seems to influence the degree of maturity of people development processes, and therefore the organizational capabilities required for the success of research-industry cooperations.

Other conclusive considerations are presented below.

Conclusions

We proposed an initial understanding of the operational dynamics of research-industry cooperations and their challenges in ROs based on the microfoundations approach (Felin *et al.*, 2012). The absence of detailed studies focused on the proposed theoretical intersections (i.e., between the management of RO researchers and research-industry cooperation) stands out as a motivation for this research, which also brings other contributions.

In the theoretical field, the theoretical framework (Figure 1) and the analytical variables as a function of the microfoundations of ROs (Table 1) derived from the specificities of these organizations proved to be useful for the proposed diagnosis. The use of specialized literature related to the particularities of the organizations under study avoids the adoption of approaches from other contexts and with dubious benefits.

For practice, we expect that the findings consolidated in Table 2 and the suggested management actions will be relevant to the managers of the investigated units for the proposal of changes. In a broader and non-positivist sense, we emphasize the important insights brought by the case studies and the possibilities of using their results in similar contexts.

The case studies indicate that the development of greater internal collaboration for achieving effective technological deliveries permeates, in the existing spaces of autonomy, the need to prioritize the institutionalization of people management programs that address the peculiarities of R&D&I, especially in essential areas, including career development, assessment plans and T&D programs. The challenges in these areas, such as the need to develop cultural, managerial and business skills, require paradigm shifts and continuous and long-term actions.

The understanding of people management as a process with reciprocal gains in which organizational effectiveness is enhanced through the achievement of institutional and individual objectives is another important aspect. However, the motivational mechanisms that contribute to the satisfaction of researchers working in cooperative research are aspects not directly explored in this study and still poorly reported in the literature, justifying the need for further research.
Moreover, despite the recognized importance of individuals in the R&D&I processes (Collins & Smith, 2006; Taggar, 2002; Zhou, Hong & Liu 2013), when considering the macro-context of operations of the ROs studied and their normative dependence (in relation to the laws and public resources), it is possible to conclude that the career development plan of Brazilian public researchers is a debate still little promoted by public policy makers. We also highlight the remarks of some interviewees about the restrictions of traditional models of remuneration and the assessment of scholarship holders oriented to scientific production, which cast a glance at funding bodies and the importance of global changes not restricted to ROs in order to adapt to the demands for technological innovation in Brazil.

Concerning the limitations of this study, we cite the restriction of our line of investigation to the organizational boundaries of ROs, consistent with the proposed microfoundations approach. Furthermore, given the use of a qualitative method we did not aim to describe

the relationships among the analytical variables (Table 1) – although initial propositions have been raised – nor define generalizable challenges. These are the aspects that could be further explored in new research cycles, along with the application of new methodological approaches. Trust in research-industry cooperations and competency development in international cooperations are other topics related to this research that could provide its continuity.

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