Analysis of determinants for Open Innovation implementation in Regional Innovation Systems

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Abstract

This study deals with the challenge of implementing an Open Innovation strategy in Regional Innovation Systems. In this context, our research question is: can a Regional Innovation Systems be a favorable environment for Open Innovation implementation? To address this question, the main objective of this paper was to identify and analyze the determinant factors for a successful implementation of Open Innovation in Regional Innovation Systems. The factors were empirically tested through qualitative research involving seven of the key actors in a Regional Innovation Systems in the Paraná state, in southern Brazil. The results suggest that some of the determinants factors and conditions for Open Innovation implementation are: proximity and close relationship with Higher Education Institutions; existence of a governance system to intermediate relationships with knowledge actors outside the regional system; mechanisms of relationship network and knowledge absorptive capacity by the firms constituting the Regional Innovation Systems; and provision of public support (e.g., incentives, funding, infrastructure). Since these determinants are present in the Regional Innovation Systems in question, we conclude that the Regional Innovation Systems offers a favorable environment to Open Innovation implementation. Additionally, we highlight a number of contributions and implications for academics, practitioners and those interested in Regional Innovation Systems governance.

Introduction

Governments have been increasingly dedicating efforts to strengthen the existing relationships between innovation and geographical boundaries by establishing dedicated policies, particularly regarding scientific and technological development (Buesa, Heijs, Pellitero, & Baumert, 2006). Regional development, on the other hand, requires dedication and commitment by a number of actors, such as public research institutes, firms, Higher Education Institutions (HEI), and regional government agencies, whose complex interrelationship constitute an innovation habitat. In particular, the Regional Innovation Systems (RIS) have emerged as focal points of innovation, technology and technical training, orchestrating the identification of industrial demand in these areas and facilitating relationship and interaction between private firms, researchers and other institutional actors (Asheim & Coenen, 2005; Casali, Silva, & Carvalho, 2010; Tödtling & Trippl, 2005). Besides, RIS enable a continuous flow of knowledge exchanges between constituting actors, provide qualified human resources and financial incentives, and promote legal and intellectual propriety management support

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(Wang, Vanhaverbeke, & Roijakkers, 2012). Given these characteristics, it can be argued that RIS are potentially favorable environments for practices and strategies of Open Innovation (OI) implementation.

Although literature on OI is already mature, theory and practice about OI implementation is still rather limited and fragmented (Wikhamn & Wikhamn, 2013), and does not yet fully cover a number of specific topics. In particular, there is a lack of academic research on OI implementation in RIS. In this context, the research question addressed in this paper is: can a RIS be a favorable environment for OI implementation? In order to answer this question, the aim of this paper is to identify and analyze the determinant factors for a successful implementation of OI in RIS. The identified factors were empirically tested through qualitative research involving seven of the key actors in a RIS in the Paraná state, in southern Brazil.

The main contribution of this paper is the expansion of the current academic discussion about new applications and opportunities for OI implementation. This research is focused on RIS, which can be an interesting setting for OI strategies. Besides, this work can foster additional academic research in this topic in order to generate new knowledge about the link between RIS characteristics (e.g., structure, governance, practices) and innovation performance results, including results relating to OI adoption. For managers, this work brings also an important contribution, as the results of this research private may be used by firms participating in a RIS to guide the implementation of specific OI practices aligned with existing opportunities in collaborative partnerships, public infrastructure and incentives, availability of technological resources, legal support and innovation policies.

This paper is structured in five sections. After this Introduction, 'Literature review' section presents the theoretical foundation for the empirical research, while the 'Methodological procedures' section describes the methodological procedures employed in the research. Next, sections 'Research method' and 'Results', respectively, report and discuss the results and present the conclusions, limitations, and suggestions for future works in the topic.

Literature review

Innovation and OI strategies

Innovation is an evolutionary process of collective learning in which different stakeholders (firms, research institutions, customers, governments, financial institutions) can unite and cooperate to conduct collaborative projects (Tödtling & Trippl, 2005; Van Mierlo, Leeuwis, Smits, & Woolthuis, 2010). In this context, the OI approach consists in knowledge inflows and outflows that accelerate innovation development and expand innovation commercialization (Chesbrough, 2003; Rahman & Ramos, 2010). Effective OI requires a flexible and dynamic organizational structure based on collaboration (Chesbrough, 2012). More importantly, OI can positively impact business performance by increasing innovation capabilities (Cheng & Chen, 2013), sharing risks and resources, reducing product
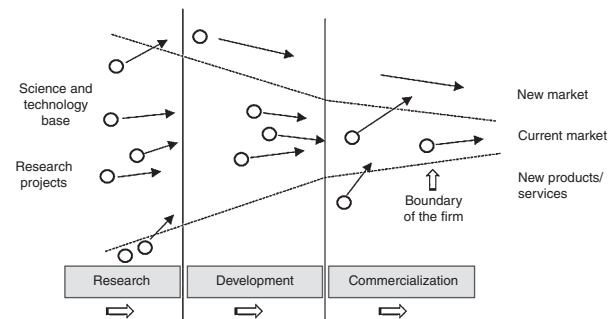

Fig. 1. Innovation funnel (*Open Innovation*).
Source: Adapted from Chesbrough (2003).

development times, improve employee participation and increase access to new knowledge, technologies, and markets (Ades et al., 2013; Enkel, Gassmann, & Chesbrough, 2009; Huang, Lai, Lin, & Chen, 2013; Kumar, Boesso, Favotto, & Menini, 2012; Parida, Oghazi, & Ericson, 2014; Rahman & Ramos, 2010).

The classic concept of innovation funnel advanced by Chesbrough (2003), shown in Fig. 1, divides the OI process in three main stages: (i) research projects/investigation; (ii) development; and (iii) commercialization.

In the research stage, firms search for ideas, concepts, partnerships and projects from technological and scientific sources. This model emphasizes the fact that external opportunities have to be better explored, allowing the development of innovation through the exploration of technologies and resources (Chesbrough, 2007). In the development stage, new opportunities, partnerships and projects can arise. Basically, however, the development stage is a filter for the projects selected in the previous stage, which can be addressed to current or new markets and can result in licensing agreements, joint product and service development projects, technology transfer initiatives, and addition of venture capital. Lastly, in the commercialization stage, external business channels are explored to generate value for the organization.

Among approaches to OI that are complementary to the funnel model, the concept of innovation value chain can be highlighted (Hansen & Birkinshaw, 2007). In this approach, the authors define innovation as an integrated and systemic process constituted by an idea generation and conversion stage followed by the diffusion of the resulting products and practices. Belussi, Sammarra, and Sedita (2010) propose an OI model for a RIS, while Miles, Miles, and Snow (2005) detail a model of collaborative and networked entrepreneurship.

Normally, the literature on OI process mention the terms inbound/inflows and outbound/outflows (Dahlander & Gann, 2010; Parida, Westerberg, & Frishammar, 2012). The former refers to the strategy more often employed by firms (Lichtenthaler, 2008), and basically refers to the internal use of ideas, knowledge and resources created externally to the firm (Sisodiya, Johnson, & Gregoire, 2013), while the latter refers to external exploration and commercialization of innovation developed internally by the focal firm using mechanisms such as licenses (Chesbrough & Crowther, 2006; Huang et al.,

2013; Huizingh, 2011). Many firms adopt both instances of OI, which can result in the establishment of strategic partnerships, collaborations, alliances, relationship networks, joint ventures, startups, technology commercialization agreements, etc. (Enkel et al., 2009; Savitskaya, Salmi, & Torkkeli, 2010).

RIS and its influence in innovation development

Cooperation, collaboration and partnerships are increasingly frequent among private firms (Tidd, Bessant, & Pavitt, 2008). Thus, in order to improve innovation performance, firms can develop cooperative relationships with suppliers, customers, competitors, governments, and intermediate organizations (Keupp & Gassmann, 2009; Lau & Lo, 2015). These relationships are, increasingly, conducted with firms and institutions geographically distant from the focal firm (Belussi et al., 2010; Rahman & Ramos, 2010; Tödtling & Trippl, 2005). In this context, an innovation system foster interactive learning among participants, establishing partnerships for cooperation and collaboration and facilitating communication and knowledge exchanges between the multiple institutional agents (universities, industry, government) (Cassiolato & Lastres, 2005; Costa, Porto, & Plonski, 2010; Garcia & Chavez, 2014; Rodrigues, Casarotto Filho, & La Rovere, 2013; Van Mierlo et al., 2010).

A RIS is a strategic environment that provides connectivity and fosters regional competitiveness through innovation (Cooke, 2005; Cooke, Uranga, & Etxebarria, 1997). The interactions between actors in such a system requires a process of feedback and reciprocity (Chaminade & Edquist, 2006) and aims at improving and expanding regional learning capacity. In this sense, a RIS seek to articulate the interrelations between distinct actors located in a restricted geographical area so they can develop innovative projects (Asheim & Gertler, 2005; Cassiolato & Lastres, 2005; Cooke et al., 1997). A RIS, incidentally, bolsters regional techno-scientific development and allows a more efficient use of resources and manpower (Baibossynov, 2013). Table 1 summarizes different authors' take on the aims and benefits of RIS.

RIS are impacted by political and economic conditions, power disputes and divergent territorial interests (Christopherson & Clark, 2007). As a result, it is necessary to implement a governance mechanism responsible for not only intermediating and facilitating stakeholder interaction, but also representing the political interests of the RIS. As a result, RIS promote integration between technological assets at universities, companies, and other institutions such as non-profit organizations (e.g., SEBRAE and other organizations dedicated to supporting innovation and entrepreneurship), technological incubators, trade associations, technology and innovation centers, research and development agencies, among others, which also contribute to fostering innovation and regional economic development. The interrelationships between actors in a RIS contribute directly to increased knowledge production and transfer, generating regional scientific and technological progress (Grimaldi, Quinto, & Rippa, 2013). Consequently, considering the interests of the different actors in a RIS, collaboration

is a joint work effort that aims at obtaining mutual results and, beyond all, requires effort and commitment with learning, knowledge, and innovation from the actors (Miles et al., 2005; Rubach, 2013).

OI in RIS and determinants for OI implementation

In order to create a theoretical framework for the empirical research, the authors identified factors and elements that were previously highlighted as determinants of OI implementation in RIS. Evidently, there are other determinants that play a role in enabling and facilitating OI implementation in RIS, such as the constitution of governance (Wallin & Von Krogh, 2010), the presence of management competencies and skills tailored for OI (Wynarczyk, 2013), factors pertaining to worker individual and collective attitude, including the regional culture (Stefanovitz & Nagano, 2014; Tödtling, van Reine, & Dörhöfer, 2011), and technological aspects associated with the existence of regional platforms and portals to support interaction between actors (Gulshan, 2011). However, the determinants highlighted and discussed next are more frequently mentioned as having a central role in OI implementation in the context of RIS.

Relationship network and absorptive capacity

A key determinant for OI implementation in RIS is the existence of a network of relationships to promote collaboration and technology transfer (Lee, Park, Yoon, & Park, 2010) and to produce and diffuse knowledge regionally (Tödtling & Trippl, 2005). Thus, it becomes essential the existence of public research institutions and mediating organizations such as technology licensing offices, innovation centers, and training institutions (Tödtling & Trippl, 2005) and supporting institutions such as technological incubators (Chang & Chen, 2004; Rodrigues et al., 2013; Tödtling & Trippl, 2005). Moreover, in order to better capture the benefits of a relationships network, it is necessary to develop firms' absorptive capacity (Cooke, 2005; De Jong, Kalvet, & Vanhaverbeke, 2010), who must recognize and transform their business using the externally acquired knowledge and information (Spithoven, Clarysse, & Knockaert, 2011). In other words, absorptive capacity is how companies make use of external sources of knowledge, integrating them with their research and development activities through a process of social interaction and mutual learning (Grimaldi et al., 2013).

RIS intermediation with outside actors

Another determinant for OI implementation in RIS is the existence of a governance system to intermediate relationships with knowledge actors outside the regional system (Belussi et al., 2010; Chen, 2015; Tödtling & Trippl, 2005). In new product development processes, firms may need additional competencies or partners that are not available within the local system (Chen, 2015). In this way, the RIS may intervene helping such companies to find and connect with the resources necessary to their innovation processes.

Table 1
RIS aims and benefits.

Aims and benefits	Authors
To establish communication, engagement and mutual trust between actors and analyze the relationship between the RIS components and economic growth.	Hajek, Henriques, and Hajkova (2014)
To promote collective learning and build systemic relationships to share tacit knowledge.	Chang and Chen (2004)
To establish governance mechanisms, select partners, manage actions, attitudes and productive, business, commercial and technological relationships between private firms and institutions; to evaluate the innovation network efficiency; to strengthen partnerships, reciprocal learning, and achieve technological objectives by fostering collaborative research and development activities.	Cooke et al. (1997); Suzigan, Garcia, and Furtado (2007); Arranz and Arroyabe (2012)
To develop cooperative projects and partnerships; to generate international visibility; to strengthen the institutional and geographical context; to foster connectivity and facilitate innovation	Rodrigues et al. (2013); Bernard, Fadairo, and Massard (2013)

Source: Bibliographic research.

Provision of public support

Public support is also a determinant for OI implementation in RIS (Chang & Chen, 2004; Vorley & Nelles, 2010). Innovation policies can be a direct motivator for interaction between innovating actors (De Jong et al., 2010). In this case, governments can use regulatory power, control (directly or indirectly) and articulate partnerships (Zhao, Cacciolatti, Lee, & Song, 2015). In other words, government actors are in charge of the creation of mechanisms and structures that foster collaboration through public policies for exploring, developing and transferring technology, public funding programs for innovation developing and technical education, and laws for regulating intellectual propriety and partnership contracts (Chaminade & Edquist, 2006; Pervan, Al-Ansaari, & Xu, 2015; Zhao et al., 2015).

Proximity and close relationship with HEI

Proximity with universities and other higher education and research institutions is frequently mentioned in the literature as one of the key determinants for OI implementation in RIS (Belussi et al., 2010; Gassmann, Enkel, & Chesbrough, 2010; Padilla-Meléndez, Del Aguila-Obra, & Lockett, 2013). Universities are important actors in mediating relationships in RIS, contributing to its development (Garcia & Chavez, 2014) as sources of information, technological development and knowledge transfer (Breznitz, O'Shea, & Allen, 2008; Freitas, Marques, & Silva, 2013). Particularly, HEI and research institutes offer scientific support to private firms in new product and process development, provide access and use to technical services and specialized equipment, supply education and training for the workforce (Freitas et al., 2013) and directly promote innovation through academic startups and spin-offs (Breznitz et al., 2008; Draghici, Baban, Gogan, & Ivascu, 2015).

However, it is worth noticing that the relationship between universities and the private sector also involves challenges and difficulties. In some cases, path-dependency has led universities to specialize in research areas or topics that are not directly relevant to local companies (Tödtling & Kaufmann, 2001), or academic efforts in research and development are simply not efficiently communicated and diffused (Baibossynov, 2013).

Conversely, private firms innovation problems may not be academically relevant (Tödtling & Kaufmann, 2001). To Breznitz et al. (2008), universities' commercialization and technology transfer initiatives must address both academic research interests and the needs of the region it is located, and often require a deep cultural change in the HEI (Wynarczyk, 2013).

Some challenges are particularly applicable and relevant in Brazil. For instance, Breznitz et al. (2008) mention the scarcity of investments for research projects in universities, while Ades et al. (2013) point out that universities often lack competences to manage intellectual propriety and have difficulties navigating through both academic regulations and firms legal requirements, which results in a lack of joint patents. In a similar tone, Freitas et al. (2013) highlight barriers related to technical uncertainties, bureaucratic administrative procedures, long response times and lack of rules about the appropriation of outcomes in joint innovation projects between universities and private firms.

Methodological procedures

Research context

This research was conducted in the Southwestern Region RIS, in the Brazilian state of Paraná. It is considered a model RIS for the state that stands out for the high level of HEI, and is oriented toward the information technology industry. The explicit objectives of the RIS are: (i) to promote specialized training for the workforce, (i) to help fundraising for research projects, (iii) to expand innovation programs, and (iv) to promote competitiveness among small firms. As shown in Fig. 2, the RIS is part of a network of relationships and mutual influence between the different groups of technological, academic, business, governmental, and institutional actors that aim to stimulate innovation and the interactions between universities and firms through technological transfer.

According to Gonçalves (2007), the Southwestern Region RIS has a shared network of technological assets, local and regional actors, a number of partner and supporting institutions, a friendly legal environment and a context of regional public policies that is favorable to innovation support. Fig. 3 shows
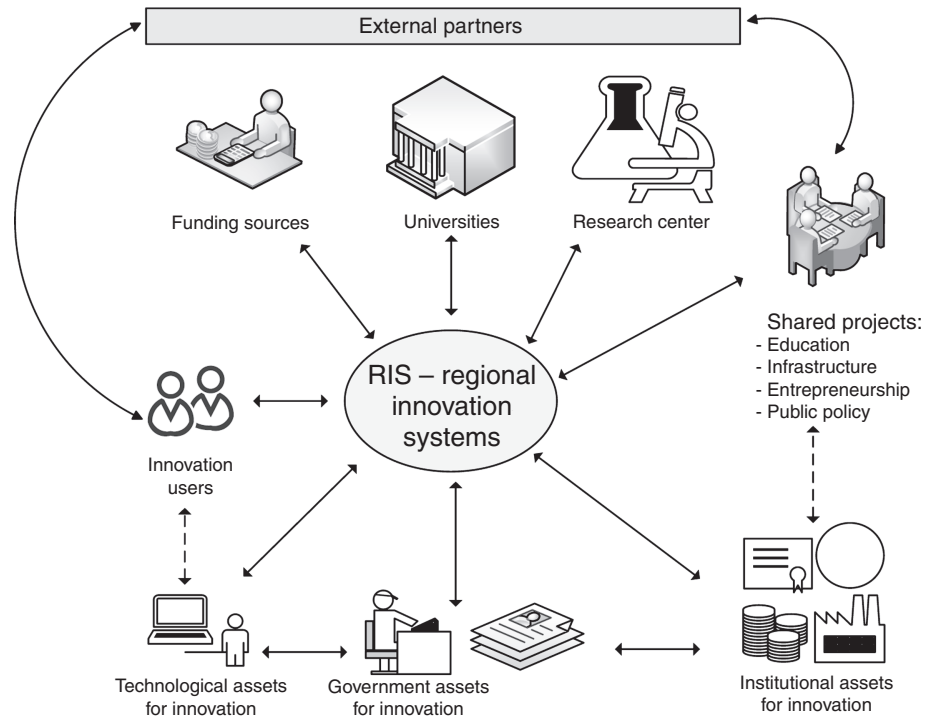
Fig. 2. Southwestern Region RIS conceptual constitution.
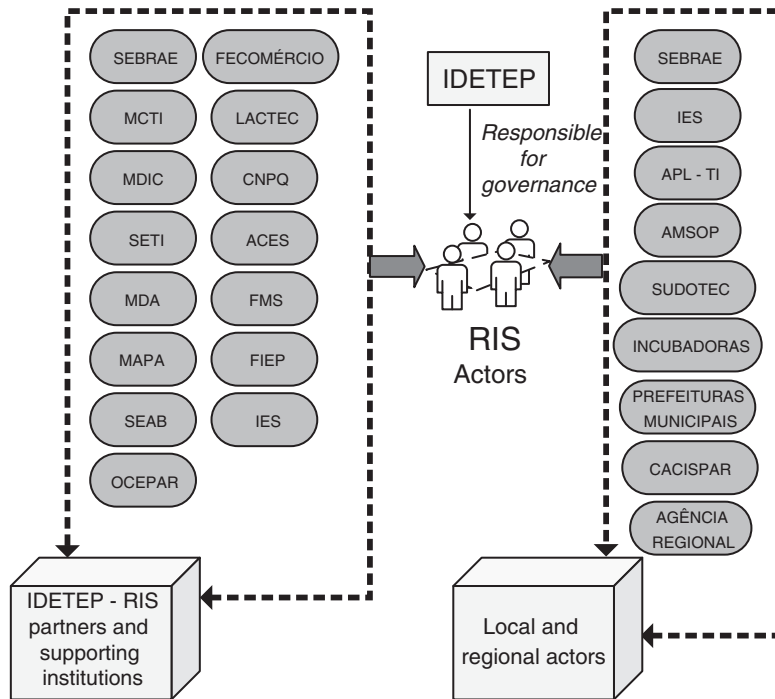*Source*: Adapted from http://www.sebraepr.com.br.

Fig. 3. Southwestern Region RIS structure and components.
Key: SEBRAE, Serviço Brasileiro de Apoio à Pequena Empresa; FECOMÉRCIO, Federação do Comércio do Estado do Paraná; MCTI, Ministério da Ciência e Tecnologia e Inovação; LACTEC, Instituto de Tecnologia para o Desenvolvimento, Centro de pesquisas tecnológicas; MDIC, Ministério do Desenvolvimento, Indústria e Comércio Exterior; CNPQ, Conselho Nacional de Desenvolvimento Científico e Tecnológico; SETI, Secretaria da Ciência, Tecnologia e Ensino Superior; ACE's, Associações comerciais e empresariais; MDA, Ministério de Desenvolvimento Agrário; FM'S, Fundos municipais de Inovação; MAPA, Ministério da Agricultura Pecuária e Abastecimento; FIEP, Federação da Indústria do Estado do Paraná; SEAB, Secretaria da Agricultura e do Abastecimento do Paraná; IES, Instituição de Ensino Superior; OCEPAR, Organização das Cooperativas do Paraná; APL-TI, Arranjo Produtivo Local de Tecnologia de Informação; AMSOP, Associação dos Municípios do Sudoeste do Paraná; SUDOTEC, Associação para o desenvolvimento Tecnológico e Industrial do Sudoeste do Paraná; CACISPAR, Coordenadoria das Associações Comerciais e Empresariais do Sudoeste do PR.
Source: Adapted from http://www.sebraepr.com.br.

the overall structure and constituting actors of the Southwestern Region RIS.

The importance of actors' interrelationships within the RIS is evident, with special emphasis to the participation of direct and indirect partner institutions at the state and federal levels that support and back up RIS innovation initiatives at the regional level. Examples of such partner institutions are the federal government Ministry of Science, Technology and Innovation and the Ministry of Development, Industry, and Foreign Commerce. Although these institutions are not part of the RIS in the geographic sense, are the responsible for creating and enforcing policies for scientific research, innovation, and industrial development which ultimately impact the RIS.

Since 2013, RIS governance is the responsibility of IDETEP (Instituto de Desenvolvimento Tecnológico, Pesquisa e Inovação do Sudoeste do Paraná), an institute created by system governance to coordinate integration between educational and research institutions, municipalities, funding agencies and private firms. IDETEP supports and conducts practical initiatives of technological transfer and innovation in partnership with local firms (C.G.C. Gonçalves, E. Ferreira. Personal communication, July 07, 2016).

Relevant actions conducted by the RIS include supporting the formulation of innovation laws at municipality level in a number of cities and the operationalization of a state law of stimulus for the electro-electronic industry aimed at attracting companies for the region and bolstering regional technology and innovation development. Complementary actions supported by the RIS include the creation of SudoValley (a community of startups) and technological incubators, the implementation of technological hotels in local HEI, and the establishment of specific municipal councils, centers, and workgroups in many Southwestern Paraná cities. The RIS also promoted seminars, forums and internal workshops to integrate researchers and address specific demands related to technology transfer, such as short courses on drafting patents. Similarly, the RIS promoted events for larger audiences, such a bi-national workshop to align research interests and establish research collaborations with Argentinian researchers, and technical visits in companies and technological parks throughout the nation. Finally, the RIS has managed to include the Southwestern region in the Paraná Virtual Technological Park (PTV), an initiative that aggregates eight technology development centers throughout the state with the objective of integrating technological innovation resources and technology-based companies in a virtual platform through which the PTV expects to foster the sharing of management and competitive intelligence practices and promote technological cooperation.

Research method

The nature of the research reported in this paper is qualitative, descriptive and exploratory. First, a bibliographic review was conducted on the topics of RIS and OI (Gil, 2002). Next, following Ribeiro and Nodari (2009), a qualitative empirical study was performed to describe, investigate and explain in detail a contemporary and complex case that is representative of the research topic at hand, that is, OI implementation in RIS (Gil, 2002; Richardson, 1999).

Data collection used individual interviews with key respondents for each actor that constitutes the RIS. A first contact was established by the authors that included an explanation about the objective and the importance of the study at hand. Next, seven face-to-face semi-structured interviews took place in the months of May and June 2013, with an average length of 60 min each. Interview guidelines consisted of a questionnaire with 10 open questions elaborated by the authors dealing with the topics of the theoretical framework described in 'Literature review' section. The criterion for selecting interviewees was straightforward: at least one respondent from at least one institution representing the key actors of the RIS, with convenience factors (availability and physical proximity) influencing the selection of the specific individuals to represent the institutions. Nonetheless, researchers made sure that all respondents were managers, directors or presidents with detailed knowledge of strategic and operational aspects related to the institution's participation in the RIS. Table 2 summarizes interview data.

Qualitative data was analyzed and interpreted using content analysis, whose techniques are frequently used when researchers want to perform a detailed examination of meanings and actions of individuals and organizations and transform qualitative data in structured information (Freitas & Janissek, 2000). In this kind of analysis, parts of the transcribed interviews are annotated with thematic categories, formed by grouping similar elements under a common meaning (Bardin, 2011; Patton, 2002). The use of content analysis allows the processing of communication and discursive data into objective, systematic and quantitative information that can be further analyzed, classified and interpreted (Bardin, 2011). In the case studied, researchers considered a first approach to categories using the elements and keywords more frequently mentioned in the interviews. Moreover, researchers independently highlighted parts of the transcribed text that, according to their interpretation, were specifically relevant to the research objectives. Next, researchers compared their notes and grouped the most relevant parts and notes according to similarity in interpreted meaning. Based on this similarity-based content analysis procedure and the semantic categories formed, researchers were able to produce a list of common response elements for each question in the interview guidelines, which were then grouped into the five main thematic categories.

Results

In this section, the five thematic content categories arising from the interviews (Table 3) are presented and discussed.

Knowledge about the RIS and its impact in regional innovation

The first content category that emerged from the interviews is the unanimous perception, among respondents, that actors in the RIS have full knowledge about the role of the RIS and its impact in regional innovation projects and initiatives. Interviewees were fully aware that the RIS has intensified its participation in the

Table 2
Interview data.

#	Institution	Main objective in the RIS	Respondent
1	IDETEP	To operationalize the actions of the RIS, fostering cooperation between firms, HEI, regional entities and public offices and agencies	Director
2	Private HEI	To provide higher education and research activities	Director
3	Public HEI	To provide higher education and research activities	Director
4	REGIONAL DEVELOPMENT AGENCY	To promote and stimulate integrated regional development	Director
5	SEBRAE	To support entrepreneurs and small business owners.	Business manager
6	FINDEX (Incubator)	To support the establishment and early growth of innovative and technological new enterprises in the city of Francisco Beltrão	Manager
7	SUDOTEC	To support business and technological development for the local apparel and software industries	President

Source: Authors.

Table 3
Thematic content categories.

#	Category
1	Knowledge about the RIS and its impact in regional innovation
2	Relationship network
3	Commitment toward the RIS
4	University–industry interaction benefits and challenges
5	Potential of the OI approach in the RIS

Source: Authors.

regional discussions about innovation and technical knowledge transfer. All respondents agreed that the RIS has become an agent of transformation by helping fulfill a perceived lack of integration between research-oriented institutions and the private sector as well as contributing to the survival and success of new business, particularly those that make use of knowledge and technology. Finally, interviewees declared that the RIS positively impacted the local private sector by facilitating the construction of a favorable institutional environment for innovation and technological development, with special emphasis on small and medium enterprises (SME).

Relationship network

In this category, respondents highlighted that the regional events promoted by the RIS have been essential in fostering a culture of positive relationships and integration between private sector firms and the other institutions in the RIS and contributing to the success of collaborative projects. The events and practical initiatives promoted by the RIS allow increased commitment toward the RIS by local firms and improve idea and information exchange between participants, especially when university–industry interactions are considered. Besides, interviewees positively highlighted the electronic platform as an essential tool for building and maintaining this relationship network. In the respondents' perception, the platform main benefits include the possibility of identifying and aggregating innovation-related demands from the private sector and matching these demands with local researcher expertise. Such results are in line with expected benefits of a similar tool proposed by Kathan, Matzler, Füller, Hautz, and Hutter (2014).

Still regarding relationships within the RIS, respondents agreed with the assertion that the connection between partners and actors in the RIS is highly dependent on the initiative of the institutional leader. This is similar to what was reported in Fritsch (2001), who argued that effects of regional cooperation efforts are limited by actors' willingness to collaborate and the effectuation of such willingness into concrete actions.

Commitment toward the RIS

In this category, respondents emphasized their institutions' constant engagement with the RIS as well as their personal commitment and encouragement. Different interviewees described how the institutions they represent were present in a number of high-visibility initiatives promoted by the RIS. The respondents were also highly optimistic regarding actors' increased openness and receptiveness after joining the RIS, citing increased number of collaborative projects and perceived changes in organizational culture as evidence.

As highlighted by Arranz and Arroyabe (2012), the existence of RIS governance mechanisms and structures is an important driver of success. In the case studied, IDETEP is the institution in charge of system governance. All respondents were aware of such role, and many cited concrete actions conducted by the IDETEP such as the formulation of a strategic plan for the RIS, the mediation of collaborative partnership agreements between local universities and private firms, and the support of fundraising activities by firms and projects. Besides, a few respondents cited IDETEP's participation in the establishment of technological, innovation, and entrepreneurship nuclei throughout the region.

In general, important aspects of the political, managerial and operational roles played by the RIS were praised by the respondents. Particular positive aspects of the RIS emphasized by at least four interviewees include leadership, strategic planning and political maneuvering capability. Moreover, respondents noticed that some institutions (e.g., SEBRAE and HEI) have a proactive leadership role in the system, which is understandable given their institutional roles and responsibilities. Additional positive aspects associated with RIS activity that were highlighted by the respondents include specific changes in the business model of some actors (which, in the respondents' view, contribute to

a higher general level of systemic innovative capability and regional development); specific partnerships for technological missions and participation in regional and national innovation events; examples of joint projects involving a number of local firms; specific agreements, conventions and contracts of technology transfer between actors; and overall improvement in regional technology assets.

University–industry interaction benefits and challenges

In line with the arguments of Fritsch (2001) and Santos and Diniz (2013), interviewees agreed that a regional competitive environment characterized by innovation and technological development requires healthy university–industry interactions and the participation of researchers in practical, market-driven applied research and development projects. Thus, in order to strengthen this interaction, the studied RIS has acted in a number of ways. Respondents largely identified these actions, which include signing technological cooperation agreements between universities, private firms and other institutions; creating and supporting a technological hotel and technology incubators; proposing and executing collaboration conventions and agreements for joint fundraising; promoting academic workshops, courses and seminars on planning, innovation, and entrepreneurship for practitioners and businessmen; and conducting technology missions in Brazil and abroad. In most cases, these actions were not only recalled by the interviewees, but also assessed as positive efforts toward an improved university–industry regional integration.

Regarding the challenges associated with university–industry regional integration, respondents pointed out aspects such as administrative bureaucracy, technological uncertainty, lack of trust, time limitations (such as slow response time by research institutions), overly complex technology transfer processes and practical difficulties in drafting intellectual propriety rights contracts and patents. It is worth noticing that most of these challenges have been identified and described by previous literature (e.g., Freitas et al., 2013; Padilla-Meléndez et al., 2013).

Moreover, a critical aspect cited by most interviewees regards what they perceive as incomplete and deficient workforce training in technical and business skills. Respondents pointed out that workers graduated in local HEI are often not ready, requiring additional training in specific techniques, tools, systems and methods that are commonly employed by local firms. Respondents mentioned possible workarounds for this issue. For instance, it was reported that information technology firms were able to show HEI professors some of their current technical problems, which helped generate a reflexive process of curriculum revision in some undergraduate courses aimed at including more contemporary techniques and programming frameworks in the classroom. Alternatively, Freitas et al. (2013) suggest an incentive system for improving university–industry integration, including tax breaks, support for knowledge transfer mechanisms and rules for allocating public funding that could be used as inspiration by the RIS studied.

Lastly, in order to improve university–industry relations, some interviewees argued that firms must rethink their own organizational values and principles regarding research and development. This notion is well established in the literature. For instance, Fabrizio (2009) pointed out that firms with more competencies and resources dedicated to research and development are able to extract more benefits from collaborations with external researchers.

Potential of the OI approach in the RIS

This category deals with the potential of OI implementation in the studied RIS, the current knowledge of the interviewees about the topic and interviewees' perception of other actors' readiness for implementing OI and knowledge on the topic. Although respondents declared that the institutions they represented had, in the past, practiced some form of OI, the general consensus was that knowledge on the topic and the applicability potential for the RIS at hand was rather limited.

Those few respondents that declared at least a passing knowledge about OI argued that its main objective is to stimulate innovative ideas and new ways of thinking. As one of the interviewees declared, "OI is the opposite of closed innovation, meaning that firms allow their own ideas, researches, thoughts to flow outside the boundaries of the company [. . .] because they understand that by doing so they will be improving product development, better addressing customer needs and properly orienting themselves toward what the market wants". Another respondent said that OI is very important to the RIS and the overall regional technological development, because it is "a method to co-create innovative products or processes that effectively incorporates external stakeholders". Answers like these reinforce the notion that, although popular, OI is actually still sparsely explored (Huizingh, 2011). However, results have largely underscored the potential of the OI approach in the studied RIS, since its contextual characteristics are mostly aligned with the determinants for OI implementation most often mentioned in the academic literature.

Notwithstanding the positive elements present in the RIS, results suggest that some benefits are still underexplored in that particular regional context. In particular, there is widespread ignorance about (and consequent lack of exploitation of) laws that promote, facilitate and enable innovation at firm level, be it at the municipal, state, and federal levels. Similarly, respondents agreed that actors in the RIS are almost absent from public calls for innovation projects at the federal level, and specific regional calls are unheard of.

Finally, results suggest that two additional critical factors must be developed in order to improve the potential for OI implementation in the studied RIS. First, there is a pressing need for further structural support for regional technological incubators and parks. Second, it is necessary to improve the electronic platform that connects the actors that constitute the RIS, so that innovative organizations and customers may be able to interact directly.

Final remarks

The main conclusion of this paper is that the Southwestern Region RIS is a favorable environment for innovation, in general, and the implementation of OI strategies and approaches, in particular. The presence of the following determinants is the main argument for that conclusion: presence of healthy university–industry interactions; existence of strong, active RIS governance mechanisms; provision of effective public support (in the form of specific local legislation and public policies, municipal councils work groups, technology parks and incubators and a thriving community of startups); regional vocation toward the information technology industry; intense promotion of events on innovation, collaboration, and information exchange between actors; and the insertion of the RIS in the statewide technology park.

The main contribution of this research is the expansion of the current academic discussion about new applications and opportunities for OI implementation, opening new venues for research involving specific contexts such as the RIS described in this paper. Besides, this work contributes with RIS governance, so that this topic may be brought to public discussion. As such, we expect to stimulate formulation of new, improved public policies to foster innovation at the regional and state levels. We also expect that this paper will be an instrument of dissemination of the concept of OI among RIS participants, in particular among those that constitute the studied RIS. It clear to the researchers the actors of the studied regional system are open, accessible and committed to the success of the RIS; we hope this effort will also foster similar positive effects in actors from other RIS.

Among the limitations associated with this research there is the fact that the particularities of each institution and organization were not thoroughly analyzed. These particularities may influence, above all, respondents perceptions about the potential of OI implementation in that particular organization, but also all over the RIS. Examples of such particularities include the specific commercial activity performed by the organization, the level of technological resources and competences, level of technical expertise of the workers, cultural and management elements, among others. Similarly, the study did not include the totality of RIS actors, and we were limited to a single interview for each participating organization. Although respondents were qualified to represent their organizations, it is evident that different views and perspectives about OI preparedness and potential can coexist within each organization, and we failed to capture such nuances. These limitations suggest that further research on the topic is necessary, including larger samples and more profound research instruments. Moreover, the research provided only a picture of perceptions of a situation static in time; a longitudinal approach to understanding the potential of OI implementation would be welcomed in future studies. Similar investigations in different RIS may also bring important insights about comparative characteristics and determinants.

Conflicts of interest

The authors declare no conflicts of interest.

Acknowledgements

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