

University research centers: research environment characterization

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Abstract

The possibilities for closer relations between universities and companies through University Research Centers (URCs) have created opportunities for knowledge development and technological advancement, among other advantages. Understanding existing relationships between these actors improve technological and social development of this environment. This paper aims to understand how the collaborative environment formed by URCs, Universities, and Companies is characterized. Through a systematic literature review, based on searches in the Scopus and Web of Science, 63 articles made up the final sample. The results show the characteristics of URCs, motivations of the actors to establish relationships, main modalities and forms of collaboration, measurement of results of collaboration, performance of URCs, and knowledge and technology transfers among employees. The research reveals that the human capital theory, the resource-based view, the institutional theory, and the institutional logic are the main theoretical lenses used in the analyzed studies. Finally, we present a framework that integrates the discussed elements.

Keywords: Research Centers. Theories. University research.

Centro de pesquisa universitária: caracterização do ambiente de pesquisa

Resumo

As possibilidades de estreitamento das relações entre universidades e empresas por meio dos Centros de Pesquisa Universitária têm gerado oportunidades de desenvolvimento de conhecimento e avanço tecnológico entre outras vantagens. Entender as relações existentes entre estes atores, certamente, produzirá melhorias no desenvolvimento tecnológico e social que permeiam esse ambiente. Este artigo visa compreender como se caracteriza o ambiente colaborativo formado por CPUs, Universidades e Empresas. Como estratégia de pesquisa, optou-se pela revisão sistemática da literatura que, a partir das buscas nas bases *Scopus* e *Web of Science*, resultou em 63 artigos que compuseram a amostra final. Como resultado, descreve as características de CPUs, motivações dos atores para se estabelecer relacionamentos, principais modalidades e formas de colaboração, medição de resultados da colaboração, performance dos CPUs, assim como transferências de conhecimento e tecnologia entre os colaboradores. A pesquisa também revela que a teoria do capital humano, a visão baseada em recursos, a teoria institucional e a lógica institucional são as principais lentes teóricas utilizadas nos estudos analisados. Por fim, apresenta-se um *framework* que integra os elementos discutidos.

Palavras-chave: Centros de pesquisa. Teorias. Pesquisa universitária.

Entorno colaborativo en centros universitarios de investigación: caracterización del entorno de investigación

Resumen

Las posibilidades de relaciones más estrechas entre universidades y empresas a través de los Centros de Investigación Universitaria (CIU) han generado oportunidades para el desarrollo del conocimiento y el avance tecnológico, entre otras ventajas. Comprender las relaciones existentes entre estos actores ciertamente producirá mejoras en el desarrollo tecnológico y social que impregna este entorno. Este artículo tiene como objetivo comprender cómo se caracteriza el entorno de colaboración formado por CIU, universidades y empresas. Como estrategia de investigación, se eligió la revisión sistemática de la literatura que, con base en búsquedas en las bases de datos Scopus y Web of Science, resultó en 63 artículos que conformaron la muestra final. Como resultado, describe las características de los CIU, las motivaciones de los actores para establecer relaciones, las principales modalidades y formas de colaboración, la medición de los resultados de la colaboración, el rendimiento de los CIU, así como las transferencias de conocimiento y tecnología entre los colaboradores. La investigación también revela que la teoría del capital humano, la visión basada en los recursos, la teoría institucional y la lógica institucional son las principales lentes teóricas utilizadas en los estudios analizados. Finalmente, se presenta un marco que integra los elementos discutidos.

Palabras clave: Entornos colaborativos. Teorías. Investigación universitaria.

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INTRODUCTION

The interactions between universities, companies, and governments become increasingly intense and significant in the socio-economic context. The academy seeks a new definition for its role in approaching society and firms. The firms need to recycle their competitive alternatives to guarantee their permanence in the market. The government needs to develop public policies to benefit the community and ensure the virtuous circle. Universities, companies, and the government need to find ways to relate. University research centers (URC) can collaborate to bridge this gap as integrative agents (Youtie, Libaers & Bozeman, 2006).

The current format of the URCs, which represents a type of collaborative research, originates in the United States, in the experience among scientists and engineers in joint projects during World War II. The successful collaborations have attracted the attention of renowned researchers on the most productive way of developing scientific research and have served as a strong impulse for the formation of several other URCs in the post-war period (Etzkowitz & Kemelgor, 1998). Over the years, URCs have increased in number, in large because policymakers believe that larger-scale, team-based, multidisciplinary, strategically focused, and multi-faceted research initiatives are more likely to provide high-value, high-impact research when compared to traditional forms of individual research (Gray, 2008).

URCs play a fundamental role in fostering knowledge growth. They are also responsible for encouraging the construction of collaborative networks and the promotion of scientific and technical human capital, bringing together researchers from various backgrounds to address increasingly complex problems (Berbegal-Mirabent, Sánchez García & Ribeiro-Soriano, 2015; Bozeman & Boardman, 2003). The definition and iterative two-way understanding between URCs and external environments are critical to increasing the successful translation of university research.

The approach between universities and companies provides new perspectives. On the universities' side, researchers are encouraged to develop their studies, more pragmatic lines, going beyond the fundamental scientific boundaries (Sabharwal & Hu, 2013). For companies and governments, this is a new partner for their research and development efforts, allowing them to have access to academic resources, including facilities and highly qualified personnel (Bruneel, D'Este & Salter, 2010).

University-enterprise collaborations through the URCs have been increasingly recognized as mechanisms for opportunities for knowledge creation and technology exchange among actors, leading to synergistic effects and possibilities for virtuous circles (Geuna & Muscio, 2009). Their numerous types of results materialize and bring together students, researchers, managers, and professionals (Rogers et al., 1999) and define the profile of URCs (Corona, 2015; Stahler & Tash, 1994).

The brief contextualization on URCs demonstrates the relevance of the topic that goes beyond the boundaries of the university environment. The literature visited on the one side seems fragmented (Galán-Muros & Davey, 2017) on the other side, it opens up a range of possibilities to explore, referring to the research question: What are the main elements present in the literature that form the collaborative environment defined between University Research Centers, Universities and Firms? Consequently, the research aims to understand how the collaborative environment composed of URCs, Universities and Firms is characterized.

To reach the proposed goal, the authors used the Systematic Literature Review (SLR) as a strategy, in Scopus and Web of Science bases, increased with the use of the technique called snowballing. To be included in the sample, the articles had to meet one or more of the following criteria: describe the characteristics of URCs, actors' motivations to establish relationships, the principal modalities, and forms of collaboration, measuring collaboration results, URC performance, as well as knowledge and technology transfers among collaborators. The research also investigated the principal theoretical lenses used in the articles considered, revealing to be the theory of human capital, the resource-based vision, institutional theory, and institutional logic. Finally, the study presents a framework that integrates the elements discussed.

METHODOLOGICAL PROCEDURE

Widely used in the health area (Sackett, Rosenberg, Gray, Haynes & Richardson, 1996), the SLR has been gaining space for its application in the Social Sciences area (Petticrew & Roberts, 2006; Tranfield, Denyer & Smart, 2003). The SLR is driven by a process consisting of a sequence of pre-defined phases, being a rigorous, reliable, and auditable way, reducing subjective biases and risks of neglecting the relevant literature (Brereton, Kitchenham, Budgen, Turner & Khalil, 2007).

SLR's first step was to define the search string and other parameters. The general expressions used were (universit* OR academ* OR scientific* OR "higher education") AND (research OR investigation) AND (cent* OR lab* OR core*) searched in the title field, considering only peer-reviewed journal articles. Besides business, education educational research, and management, only papers published in English were included. The bases chosen were ISI Web of Science (WoS) and Scopus for bringing together the journals with the highest impact in the management area. There were no restrictions about the articles' publication years, being the searches in the bases carried out in May 2020.

As criteria for inclusion in the sample, only primary studies were considered, which dealt with the characterization of URCs, motivations for establishing relationships with URCs, principal modalities and forms of collaboration with URCs, measurement of collaboration results, the performance of URCs, as well as knowledge and technology transfers among employees. The exclusion criteria for the final sample took into consideration: articles published only as abstracts, or not written in English, or older version of another study already considered in the sample, or non-primary study, or study without full access condition.

The decision process for the inclusion or not of the articles counted with the active participation of both authors. This procedure aimed to minimize the probability of discarding relevant studies (Edwards et al., 2002). In terms of configuration, one researcher selected the papers, and the second reviewed the decision to include or not in the sample, following the recommendations of Felizardo, Nakagawa, Fabbri and Ferrari (2017), which resulted in Table 1.

To expand the bibliographic base consulted, the authors put into practice the secondary strategy called snowballing (Wohlin, 2014) that, like LSR, sought primary studies. Petersen, Vakkalanka and Kuzniarz (2015) argue that it is possible to obtain more consistent results by combining the two strategies (SLR and snowballing) since achieving primary studies with only one SLR can bring limitations related to the string parameters. Thus, the authors applied the technique to each of the 35 articles that composed the initial sample. The process resulted in 26 new studies in reverse processing and two new ones in the forward process, totaling 63 articles.

Table 1
Initial sample composition

Source	Included in sample	Excluded from sample	Inaccessible papers	Total
WoS	7	71	8	86
Scopus	13	52	1	66
Both databases	15	26	0	41
Total	35	149	9	193

Source: Elaborated by the authors.

Once defined the sample and organized the metadata, each paper was examined to provide subsidies for the URC collaborative environment in light of each inclusion criteria. General and specific data were extracted from each primary study, mapped on a separate spreadsheet. The synthesis process of the extracted data relied on two methods. The integrative, summarizing and grouping evidence, and the interpretive, organizing concepts identified as comprehensive.

RESULTS PRESENTATION AND DISCUSSION

The results section is organized according to the article inclusion criteria to facilitate the organization of the SLR. Then, the main theories used were identified and, finally, the framework proposal was presented.

Research center characterization

The literature does not agree on the precise definition of a research center, due to the heterogeneity and wide diversity of goals, varying substantially in terms of its organizational characteristics (Etzkowitz & Kemelgor, 1998; Stahler & Tash, 1994). As a common point to all, there is the intention to promote some degree of collaboration among researchers. These collaborations can be multidisciplinary, inter-organizational, intersectoral, according to the scientific and technical objectives of the center (Bozeman & Boardman, 2003; Rogers et al., 1999). There are centers specifically created to induce interactions and collaborations between researchers in various departments and disciplines, universities, industry, government, and sometimes in several countries (Lal, Boardman, Towery, Link & Shipp, 2007).

In several papers, the definition of research center proposed by Boardman and Gray (2010) has been adopted. It is an organization or unit inside a larger organization carrying out research and has an explicit mission (and related activities) to promote, directly or indirectly, intersectoral collaboration, knowledge (KT) and technology (TT) transfer, and, finally, innovation.

Bozeman and Boardman (2003) define URC as a formal organizational entity within a university that exists with the specific mission of serving research, distinct from the academic department and which may include researchers from more than one department. In this definition, there is no requirement that a URC is interdisciplinary or multidisciplinary. The authors call attention to the distinction that is, perhaps, the most important: URCs develop interactions with the university's external stakeholders, including other universities, businesses, industry, and government. Their creation bridges gaps between universities and companies that have not been filled by the universities themselves, its laboratories and academic departments and research institutes (Ponomariov & Boardman, 2010; Styhre & Lind, 2010), and that are managed separately from normal scholarly activities (Sá, 2008).

URCs are perceived as specific mechanisms by which companies and universities create organizational bridges that transcend the limits of cultural and structural differences (Nursall, 2003). Resources and infrastructure may come from the university, but they generally develop and consolidate with external funding through the efforts of its researchers (Torres Zapata, 2019). Another emerging factor in this system is alliance formation. These partnerships between universities and public and private institutions changed the way the URCs' organizational structure is defined (Magro & Wilson, 2013).

The literature also presents several taxonomies in the function of its creation initiative, its researchers' affiliation, and even the cooperative agreements. Bozeman and Boardman (2013) classify as University Research Center, State Research Center, and Federal Agencies Research Center. Santoro and Chakrabarti (2001) classify as Engineering Research Centers, University-Industry Cooperative Research Centers, and University Research Centers. It is a fact that the URCs represent most of the research centers. Even so, literature has devoted less attention to this type of centers, despite their quantitative domain. Studies based on URCs data highlighted differences with other types cited above (Boardman, 2009; Boardman & Corley, 2008), but did not address this dominant type.

Given the plurality of activities, URCs tend to have heterogeneous research portfolios and present higher managerial challenges when compared to traditional academic activities. Such challenges require knowledge of more structured management approaches by leaders (principal researchers) for organization and management of URCs (Boardman & Ponomariov, 2012), and also for dealing with a wide variety of researchers involved with industry (Gaughan & Corley, 2010). In general, the impacts of URCs tend to be diffuse, encompassing beyond academic, commercial, and social outcomes (Bozeman & Gaughan, 2007; Gray, 2000).

Motivation to establish a URCs relationship

Relevant scientific problems require multiple skills and the integration of diverse disciplinary perspectives (Carayannis, Del Giudice & Della Peruta, 2014). Mainly since the First World War, collaborations between the business and the academic field grew steadily, strengthening ties for various reasons (Geiger, 1990). The reasons why different actors, such as universities, companies, and government, participate in the collaborations have been the subject of diverse research over the decades. Table 1 presents the main motivations identified in the consulted literature.

As can be seen in Box 1, some motivations have a specific character while some are more general. In practice, actors involved can identify multiple motives. Moreover, the reasons for the involved actors must be observed, because an incompatibility can lead to conflicts, putting into play the collaboration's fruits. These motivations represent values that members perceive when creating and participating in these collaborations (Horne, Poulin & Frayret, 2010).

Box 1
Actors' motivations

Actors	Motivações
Universities	Financial support for students; patents; license agreements; spin-off creation; new product development; responses to government policies; graduate student employment opportunities; paper publication; access to relevant research problems; implementation improvement of new technologies; access to additional resources; insight into own research; research application on real issues; increased strategic power; contribution to government policies; future business opportunities; cutting-edge research possibilities; access to companies for applied research; theory-practice integration; access to research networks; access to protected markets; and creation of links with companies.
Companies	Access to highly qualified personnel; access to training and support for in-house skills development; specific problem solving; access to university facilities; access to R&D funding; commercialization of university-based technologies; access to a variety of post-experience training facilities that helped design; access to university research, consulting, and data collection; access to state-of-the-art science; knowledge exchange between university-company; risk sharing; cost reduction; internal and external image improvement and company reputation; broadening the scope of activities; creating investment opportunities; access to research networks; increasing absorptive capacity; increasing the number of talented students attracted; searching for new products and new technologies; and, acquisition of previously unavailable technologies.
Government	Increases employment; increases the absorptive capacity of companies; boosts the innovation system; increases the productivity of companies and the generation of wealth; corrects market failures in investment in R&D; accelerates technological innovation; creates research networks; increases the exchange of information between universities and companies; and, generates economic, social and cultural development.

Source: Adapted from Ahn (1995), Hayton, Sehili and Searpello (2010), Lee (2000), Lee and Win (2004), Motohashi (2005), Phillips (1991), Santoro and Chakrabarti (1999, 2001) and Styhre and Lind (2010).

Principal modalities and forms of collaboration

The literature points to different modalities of collaboration (Boardman, 2009; Bruneel et al., 2010). Their implementation forms vary according to the degree to which participants integrate (Boardman & Corley, 2008). The relationships differ according to the "level" of interactions between the actors, which can be individual, institutional, or between both levels and using the interaction modalities by which it is performed as in the case of codified knowledge (such as a scientific publication), a technological artifact (such as a prototype) or even a financial flow (such as a license transfer). The common point to any collaboration revolves around increasing the knowledge stock of at least one of the collaborators (Inzelt, 2004).

It is also necessary to differentiate the interaction sense. On one side, it is possible to observe URC's unilateral interactions with companies, such as the provision of R&D services performed by university research teams for companies. But there are also bilateral interactions through which there is a real exchange of knowledge between partners, known as a two-way bridge (Meyer-Krahmer & Schmoch, 1998). The collaboration terms between URCs and companies cannot thus all be seen on the same level (Tidd & Trewhella, 1997) and are still vulnerable to conflict (Tidd & Izumimoto, 2002).

It is possible to identify five dimensions to characterize the possible forms of collaboration (Box 2). The success depends ultimately on the partners' ability to establish trust (Le Roy, Robert & Lasch, 2016), commitment, and mutual benefit (Numprasertchai & Igel, 2005).

Box 2
Main Collaboration Modalities

Collaboration type	Interaction level	Formalization degree	Registered scientific knowledge	Technological artifact	Financial flow
Joint venture	Institutional	High	There may be	There may be	Yes
Research project developed in partnership	Institutional	High	There may be	There may be	There may be
Research contract	Institutional	High	There may be	There may be	Yes
R&D services	Individual and institutional	High	No	There may be	Yes
Hiring companies by URCs access	Institutional	High	Yes	There may be	Yes
Access to company facilities and equipment	Individual and institutional	Low	No	Yes	There may be
Access to URCs facilities and equipment	Individual and institutional	Low	No	Yes	There may be
Informal contacts between academics and company employees	Institutional	Low	There may be	There may be	No
Spin-off	Individual and institutional	Medium	There may be	There may be	Yes

Source: Adapted from Boardman (2009), Boardman and Corley (2008), Bruneel et al. (2010), Inzelt (2004), Meyer-Krahmer and Schmoch (1998) and Scott, Steyn, Geuna, Brusoni and Steinmuller (2001).

The different configurations of collaboration between URCs and firms identified in the literature produce different results. For example, it is possible to cite the knowledge stock increase of the involved parts, improvement and development of methodologies, new patents, and registration, potential researchers training with skills and competences developing, creation and development of collaboration networks, specific technical problems resolution that occurs with the companies besides new business born as university spin-off (Boardman & Corley, 2008; Rogers et al., 1999).

Measuring collaboration results

As could be seen in the previous sections, the collaboration between URCs and companies opens the opportunity to generate significant contributions for both actors. However, in practice, these potential benefits do not always materialize (Galán-Muros & Plewa, 2016) due the objectives' conflict between parts involved. The differences may be attributed to a dichotomy between divergent logics among the actors. However, there is evidence that the sociocognitive proximity between URC and firms is critical to achieving the collaboration outcomes (Lauvås & Steinmo, 2019).

The sustainability of this collaborative experience focuses on the real results of "give and take" among researchers from universities and companies. The most significant benefit obtained by the company is an increased opportunity for new research and university discoveries. On the university side, researchers are complementing their academic research, guaranteeing funds for students and equipment, and increasing access to information about their research. Although this may lead to an overload of work, given the academic commitments they make in university departments (Boardman & Bozeman, 2007), collaborative experiences tend to sustain or even expand (Lee, 2000).

Measuring the effectiveness of the relationship between URC and companies is not a trivial matter (Gray & Steenhuis, 2003). The research conducted by Santoro and Chakrabarti (1999) takes into account three dimensions: resource input in the university center, participation in the URC and companies relationship process, and the related outcomes. The express transfer capitalizes the activities between URC and companies to integrate university-based research to drive initiatives applied to the development and commercialization of new technologies. Can be measured in terms of patents, licenses, publications, and joint use of facilities and equipment (Evans, Starbuck, Kiresuk & Gee, 1993).

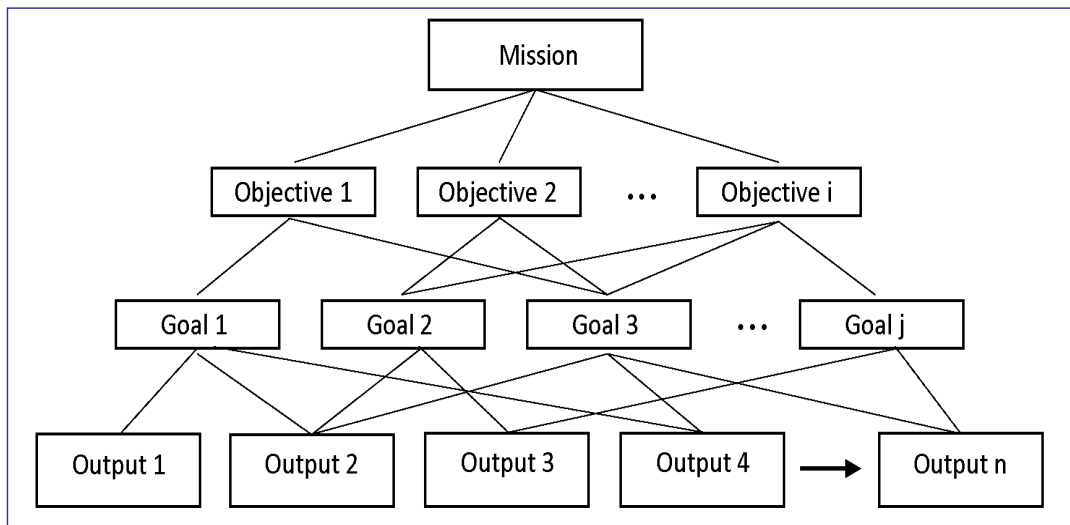
URC results measurement

URCs require long-term perspectives and clear goals (Geisler, Furino & Kiresuk, 1990). Despite the increasing demands to evaluate the performance of URCs, there are few frameworks and theoretical methods to do so. A well-succeeded center's effectiveness depends, to some degree, on the evaluation of the progress of its ongoing programs to capture its achievements (Lee, Kim & Cha, 2014; Nishimura, Goebert, Onoye & Sugimoto-Matsuda, 2018), as well as the participation intensity of researchers (Kassab, Mutz & Daniel, 2019) and managers (Gray, 2008).

The studies by Boardman and Gray (2010) and Roessner, Manrique, and Park (2010) showed evidence of gaps in URC performance assessment processes due to ecosystem complexity, lack of data, and inadequacy of traditional indicators. The structure, processes, and member morale tend to vary according to the age of the URC, which consequently influences the variation in organizational performance. It is not evident which measurement standards and criteria should be used to assess the URC's effectiveness (Cameron & Whetten, 1981).

The capacity to reach the URC goals depends on the transparent evaluation system to support decision making. Gibson, Daimb, and Dabic (2019) propose a hierarchical decision framework using quality-quantitative parameters (Figure 1). It is a model that considers the mission, objectives, goals, and outputs of the URC. It is a generalizable and measurement system to compare performances between URCs.

Figure 1
Hierarchical structure



Source: Adapted from Gibson et al. (2019).

Knowledge and technology transfer

In today's society, where knowledge and its application are the core assets, companies feel the need for a new strategic approach (Kandampully, 2002; Jansink, Kwakman & Streumer, 2005). This approach addresses knowledge as an essential innovation source and potential element for creating a sustainable competitive advantage (Numprasertchai & Igel, 2005).

Knowledge Management (KM) identifies, assembles, organizes, stores, shares, and applies knowledge, organizes the principal policies, processes, and managerial and technological tools, in light of a better understanding of processes and their dissemination by the organization (Nonaka, 1994). Its effectiveness requires a culture that values knowledge and information as an integral part of the business processes of companies. The study by Akhavan, Hosnavi, and Sanjaghi (2009) identified the critical success factors that provide KM as being human resources management and flexible organizational structure (Cooper, 2001), as well as a prone corporate culture (Rego, Pinho, Pedrosa & Cunha, 2009).

KT is one of the principal axes of the university's third mission. It allows the URCs to contribute to solving complex problems of various types (Berbegal-Mirabent et al., 2015) with potential socio-economic impacts. However, there is little information on the process by which scientific knowledge flows from the URCs to the productive and social sectors (Chang, Chen & Fong, 2016). With the globalization of higher education and technological support, KT becomes faster, more frequent, and intense among universities and URCs of different countries (Teichler, 2004), providing solutions to common problems, positively influencing mutual collaboration (Veugelers & Cassiman, 2005). From the companies' point of view, KT enables to fulfill market needs by creating products and technologies developed by researchers (Franco & Pine, 2019). Thus, collaboration is an efficient strategy to improve research capacity, especially for units in developing countries that generally have limited resources (Numprasertchai & Igel, 2005).

URC and companies' collaboration challenge seems to be how to strengthen the double-flow KT value chain. On the one side, it increases the volume of research results with potential for incorporation into the transfer process (URCs role) and, on the other side, it generates conditions for an increase in demand, i.e., a growing set of companies and public entities able to benefit from the innovative knowledge potential provided by URCs (Torres & Jasso Villazul, 2019).

TT is the practical application development process for scientific research outcomes (Heinzl, Kor, Orange & Kaufmann, 2013) related to the intentional interaction between people, groups, or organizations aimed at technology exchange through different mechanisms (Amesse & Cohendet, 2001). It associates with confidence, geographical proximity, and flexible university policies for intellectual property rights, patents, and licenses (Santoro & Gopalakrishnan, 2001). Different mechanisms can be applied in TT between URC and companies by available motivations and resources. They are categorized, based on the interaction between actors, in a unidirectional or bidirectional flow. The main motivational factors for TT involve risk reduction, such as investment in R&D or making private knowledge public, or even the originality of the technology (Lee & Win, 2004).

TT is a complex process that can follow different paths, with universities and companies participating in different phases, but summarized in two main mechanisms.

The first is where science is a driving force of transference on the side of universities' "scientific push", in the second, "market attraction" demand pulls the process. In the first case, knowledge flows through consulting, training, and technical assistance activities. In the second, the principal transfer modalities are researched by contract, research through joint projects, and the sale or licensing of ownership of research results generated in universities (Torres & Jasso Villazul, 2019).

Theories associated with the environment URC and companies

Although a unified theoretical lens, specific for the analyzed environment, its relationships, and actors, the SLR enabled the identification of the most recurrent ones. In 78% of the studies, the authors did not mention any theory. On the other side, 22% reported the use of at least one theory.

The human capital theoretical lens has been the most used. Several authors have used this theory to explain concepts involving research productivity, collaboration, and teachers' careers in academic contexts (Berbegal-Mirabent et al., 2015; Boardman, 2009; Boardman & Bozeman, 2007; Boardman & Corley, 2008; Boardman & Gray, 2010; Bozeman, Dietz &

Gaughan, 2001; Gaughan & Corley, 2010; Ponomariov & Boardman, 2010; Sabharwal & Hu, 2013; Youtie et al., 2006). When analyzing technical and scientific human capital on a specific point, the approach emphasizes research capacity at the individual level, in terms of the knowledge set and scientific skills, and how it can be affected by professional ties and networking. It is relevant to highlight the URC's role as being designed to promote technical and scientific human capital at the university (Youtie et al., 2006).

The resource-based vision served as a theoretical lens for the works of Berbegal-Mirabent et al. (2015), Boardman (2009), Boardman and Gray (2010), Bozeman and Gaughan (2007), Horne et al. (2010), Galán-Muros and Plewa (2016), Santoro and Chakrabarti (1999) and Santoro and Chakrabarti (2001). Recognizes the heterogeneous resource package (physical, human, and organizational) as crucial to advance technologies and sustain competitive advantage (Barney, 1991). Collaboration with URCs can be beneficial for companies of all sizes. While larger companies often use URC and company relationships to address pre-competitive issues with a broader time horizon, smaller companies also turn to URCs because they need to continually develop and commercialize new technologies (usually in the short term) to enter specific industries or merely remain competitive in existing industries. Thus, although motivations may vary according to the size of the organization, skills, knowledge, and access to URC facilities are significant reasons for collaborations.

From the point of view of institutional theory, the existence of a system of norms (coercive isomorphism) that regulates activities involving licensing, spin-off, TT, KT, and patents guide the possibilities of URC and companies' collaborations (Boardman, 2009; Boardman & Corley, 2008; Boardman & Ponomariov, 2007; Bruneel et al., 2010).

Elseways, institutional logic involves the basic principles of the organization by which actors interpret the reality of organizations, evaluate alternatives, and define their identities and actions. A fundamental assumption from the institutional logic perspective concerns differences and, therefore, an essential area of research deals with theorizing and empirically illustrating these global differences. Studies by Thornton (2002) and Lauvås and Steinmo (2019) address URC and companies' environments in the context of the distinct coexistence of institutional logics.

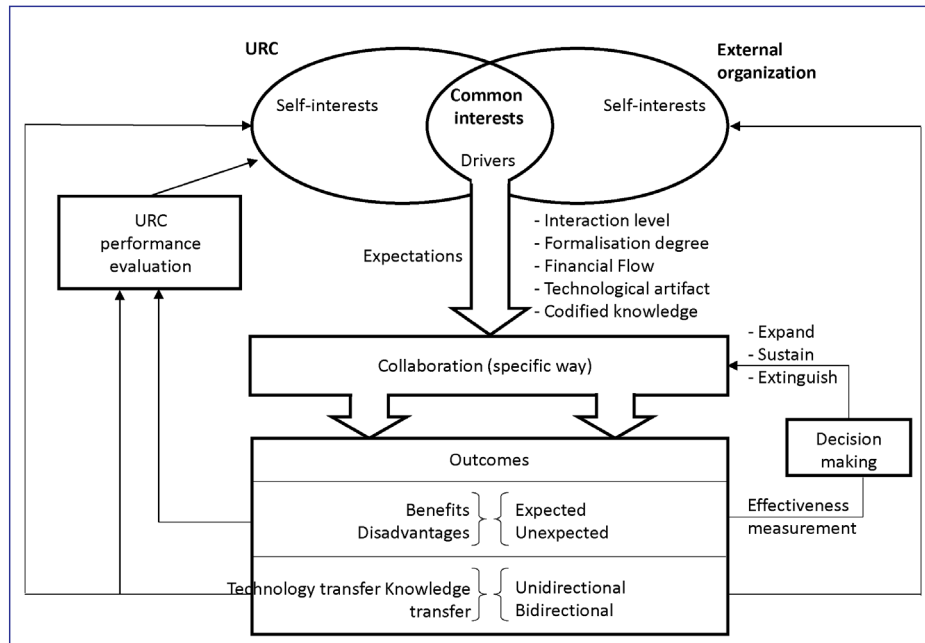
Given the peculiarities of the analyzed environment, it is not surprising that different theories support the relationships between the actors. Sometimes, some authors employ multiple perspectives in their studies. Visions indeed overlap, but this can also be understood as a step to develop a broader theory, even with limited reach, to characterize URC and companies' interactions.

Proposal for a collaborative environment framework

As a synthesis of the SLR findings, it is possible to propose a framework (Figure 2) involving the environmental actors, their relationships as well as the logical flow involved. It is a theoretical framework that brings together the principal issues presented and discussed during the research, and that cannot be neglected, especially during the URC and companies' environment design.

Despite the self-interest of URCs and organizations outside the university that guides their actions, there may be shared interests. These interests motivate both sides: URCs, their professors, researchers, and students driven by their research agendas in the light of technical and scientific human capital theory, and external organizations (companies, NGOs, professional associations, and government) each with its institutional logic and resource-based vision. Defined expectations, interaction levels, formalization degrees, financial flow, technological artifact, or even codified knowledge, there are specific forms of collaboration under the perspective of institutional theory. Its outcomes, translated into benefits and disadvantages, are measured in terms of effectiveness for decision making to expand, sustain, or extinguish the established collaboration terms. The KT and TT flow materialize, whether uni/bidirectional. At this point, it is possible to evaluate the URC performance as a function of the results generated by the collaboration.

Figure 2
Collaborative environment framework between URC and companies



Source: Elaborated by the authors.

CONCLUSIONS

The study indicates the URC creation enhances the internationalization of the themes researched in university environments, strengthens the national and international researchers' network (teachers and students), brings academia, business, and government to enable the materialization of solutions signed in co-authorship. There were 63 scientific articles selected from direct search in the WoS and Scopus bases and snowballing processes. The papers were analyzed, considering the following aspects: motivation, collaboration forms, collaboration outcomes, URC performance, knowledge and technology transfers, and the principal theory addressed. At last, it designed a collaborative environment framework of the URCs.

In terms of the principal limitations, the research carried out in the two most relevant scientific bases in the management area may have led to disregarding papers published in non-indexed journals, but which are nevertheless relevant. Furthermore, the search strategy was restricted to publications in English, which may have introduced a bias in favor of studies conducted in countries and institutions that communicate in English. Regarding the research strategy, the selective and limited sensitivity to the social heterogeneity of the contemporary world of SLR must be considered, which may have caused a bias in the research results.

As a consequence of the SLR, it is possible to point out paths for further investigations.

How the profile and skills of a URC principal investigator, who is at the vanguard of knowledge creation, can influence the URC and companies' collaborations outcomes since, in general, these professionals are responsible both for conducting their research and for the management of the centers, teams, and projects associated to the URC.

Concerning the principal investigator, it is necessary to identify how he or she understands the URCs' role and function, as a member, to support their role as the URC's principal driving force and the internal and external networks' manager.

URC and companies' collaborations may also suggest the establishment of new methodological paradigms. It is possible to establish new research methods based on emerging practices that involve the actors and their peculiar characteristics. Indeed, some methods can be born, the fruit of the search for solutions to solve technical problems posed by companies, or even be modified by the methodological transfer between one scientific discipline and another. This possible evolution seems to be one of the indirect effects that result from URC and companies' interactions and need to investigate.

As a primary effect of URC and companies' collaborations, the analyzed literature mentions the growth of the knowledge stock of the parties involved. The knowledge definition as a combination of tacit and codified knowledge leads to the difficulty to evaluate this knowledge stock increase in each of the collaborators. Future studies may address this issue.

To identify the relevance of URC and companies' environments that contain the participation of professional doctoral students for the development of theses focused on applied research, resulting in relevant artifacts for universities and companies. The consequences of the academic engagement of professors and students in URC and companies' collaborations are not clear yet. The studies do not make clear if this involvement influences the teaching-learning process, particularly in the production of intangible values.

It is possible to analyze the environment structure by including other actors with potential interaction with the URCs, such as other URCs, universities, NGOs, professional associations, and public institutions. Identify the motivations that may lead these actors to establish collaborations with URCs, the prevailing KT and TT flow, as well as ways to evaluate collaboration instruments.

The study did not locate in Brazil URCs in the researched databases. This draws attention because, as the literature describes, the URC environment is characterized by circumstances that promote or restrict its performance, as well as the collaborations that emerge. Cultural, political, social, economic aspects may influence, enhance, or restrain the emergence of URCs and collaborating with external actors. The description of URC and companies' environments in Brazil may bring relevant information about the environment and its actors and is also important for the country's public power in the formulation of specific policies.

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