

KTT STRATEGIES FOR SCIENTIFIC INSTITUTIONS: UNDERSTANDING THE PAST TO HELP BUILD THE FUTURE

ESTRATÉGIAS DE TRANSFERÊNCIA DE CONHECIMENTO E TECNOLOGIA DAS INSTITUIÇÕES CIENTÍFICAS: COMPREENDER O PASSADO PARA AJUDAR A CONSTRUIR O FUTURO.

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ABSTRACT

Purpose – This paper aims to identify the current situation of the research that analyzes KTT strategies in scientific institutions.

Design/methodology/approach – To systematize the empirical evidence that emerged from academic debates in the field, the study breaks down, through a Systematic Literature Review (SLR), 42 papers from the Web of Science database. The author divides the sample into three clusters: environmental impact, institutional effectiveness, and individual strategies, according to its unit of analysis.

Findings – The findings indicate that the alignment of KTT activities with the strategic objectives of the institutions is fundamental for positive outcomes. In addition to that, the resources for obtaining relevant results are the quality and the availability of human capital in scientific institutions, public companies, and support organizations. Finally, there is a stream of research that criticizes the exclusively commercial approach of the phenomenon.

Research limitations – The Web of Science database relies on being the manly coverage for scientific publications in general. So, due to the choice for composing this sample with papers written only in English, untranslated studies were excluded from this analysis.

Originality/value – The contribution for Literature relies on proposing a future research agenda based on identified gaps and current topics, discussing the results of previous studies that can support the decision-making of these organizations at developing efficient KTT strategies for themselves.

Keywords: Knowledge and Technology Transfer; Strategies; Systematic Literature Review; Knowledge Dissemination; Scientific Institutions.



RESUMO

Objetivo – O objetivo da investigação é identificar o estado da arte da pesquisa dedicada à análise das estratégias de Transferência de Conhecimento e Tecnologia (TCT) em instituições científicas.

Desenho/metodologia/abordagem – Através de uma Revisão Sistemática de Literatura (RSL), 42 artigos da base de dados *Web of Science* foram analisados para sistematizar as principais evidências empíricas que surgiram do debate acadêmico. A amostra foi dividida em três grupos - Impacto Ambiental, Eficácia Institucional e Estratégias Individuais - de acordo com a unidade de análise dos pesquisadores.

Resultados – Os resultados indicam que o alinhamento das atividades de TCT com os objetivos estratégicos das instituições é fundamental para resultados positivos. O principal recurso para a obtenção de resultados relevantes é a qualidade e disponibilidade de capital humano em instituições científicas, setor público, empresas ou organizações de apoio. Existe, ainda, uma corrente de pesquisas que critica a abordagem exclusivamente comercial do fenômeno.

Limitações da Pesquisa – Apesar da *Web of Science* ser a plataforma com maior cobertura científica, outras bases de dados não foram consultadas. Devido a opção de compor a amostra com artigos escritos na língua inglesa, trabalhos não traduzidos foram excluídos da análise.

Originalidade/valor – O trabalho apresenta contribuições para a literatura propondo uma agenda de pesquisa futura a partir das lacunas identificadas e temas atuais; e, para instituições científicas, discutindo resultados de estudos anteriores que podem subsidiar essas organizações no desenvolvimento de suas próprias estratégias de TCT.

Palavras-chave: Transferência de conhecimento e tecnologia; Estratégias; Revisão Sistemática da Literatura; Disseminação de Conhecimento; Instituições científicas.

1 INTRODUCTION

Education and scientific research are examples of activities that promote positive externalities to society (Autant-Bernard, 2001). This phenomenon occurs when a new service generates benefits beyond direct consumers without extra financial compensations, commonly justifying government involvement in science and education to foment innovation, capabilities, and the creation of new technologies (Hall, 2006).

In this context, universities should solidify their role as promoters of societies by encouraging a debate about the changes in the understanding of knowledge diffusion and its impacts on the economic environment (Laredo, 2007). This process resulted in the development of the higher education sector's third mission, in which universities must connect themselves with external actors to transfer knowledge and technologies, seeking mutual benefits (Wu & Zhou, 2012). The importance of the third mission to universities is evident since it is possible to verify references to its different approaches in strategic mission and vision in several institutions (Giusepponi & Tavoletti, 2018). Identifying successful Knowledge and Technology Transfer (KTT) strategies, thus, can contribute to the achievement of institutional objectives in the research sector and generate competitiveness to different stakeholders.

The author defines KTT as activities aimed at transferring knowledge or technology that could help both companies and academic institutions involved in a collaborative partnership to help to pursue its goals (Arvanitis *et al.*, 2008). Battistela *et al.* (2016), in a critical literature review, remembered that inter-organizational technology/knowledge transfer is an emergent topic and has been the subject of countless studies. The positive impacts of KTT on the economy explains its popularity since previous research found evidence that knowledge and technology transfer can result in additional revenue for scientific institutions, employment opportunities for graduate students, technological spillovers through the stimulation of R&D investment, and job creation (Siegel *et al.*, 2007).

Literature, however, has yet to develop a specific theoretical framework for KTT strategies (Arvanitis & Woerter, 2009). The economic, social, and political contexts shape the knowledge and



technology transfer practices (Bercovitz & Feldman, 2006). Those are the reasons for the relevance of studying these processes under the paradigms of strategic management. Audretsch (2014) adverted that, due to the rapid growth of multinational companies, the current focus of technology transfer relies on the research of comparative advantages within the global competition. New players, facilitated by more open economies and technical advances in transport and communication, challenge existing comparative advantages and competitiveness of countries and regions.

A variety of research explores how strategic management contributes to organizations shaping the market structures in their favor (Eloranta & Turunen, 2015). Competitive advantages depend on the ability of companies to adapt skills and resources in a dynamic environment (Teece, 2007). Companies achieve those advantages through strategic alliances in the business ecosystem (Lavie, 2006). Strategic actions, thus, can be used to manipulate the market environment and strengthen companies' performance (Helfat & Peteraf, 2003). The scientific institutions realized the importance of strategic management, using its techniques to develop a vision for the future to come. They also should learn how to deal with environmental challenges (Diniz & de Castro, 2010). Connecting KTT initiatives to strategic management might enhance technological accessibility for the industry since this discipline helps organizations by showing them how core competencies can be introduced, nurtured, and sustained (Major, 2003).

A little-explored path refers to the understanding of how different types of innovative activities should be managed (Keupp *et al.*, 2012). Despite the recognition that scientific institutions must develop strategies to promote technology transfer naturally (Sousa *et al.*, 2019), most literature reviews in this field focus on the analysis of KTT from the perspective of cooperation (Mascarenhas *et al.*, 2018), internationalization (Govind & Küttim, 2017), and innovation (Hadengue *et al.*, 2017). The current debate relies on the duty of scientific institutions to expand their environment from conservator to originator of knowledge (Etzkowitz, 2013). Such discussions have not yet consolidated a theoretical framework on KTT strategies and their implications. Overcoming the gap of analysis of the KTT from a strategic management perspective is essential for the maturing of the field, considering that this knowledge is a resource for creating competitive advantages for organizations. (Bou-Llugar & Segarra-Ciprés, 2006).

Klofsten *et al* (2019) understood the importance of universities for social change and economic growth. He proposed a research method that focuses on strategies for knowledge transfer and the exploration of relationships between universities ecosystems and the business sector since modern organizations must investigate their research activities and create a strategic transfer plan to directly respond to the needs of society (Szopa, 2015). Deiacco *et al* (2012), however, argued that the dynamics of scientific institutions are changing. He also says that the growing competition for resources, conditioned by national and international systems, increases the need for understanding the transfer of knowledge from a strategic perspective. Thus, this investigation seeks to answer the following question: what is the current situation for research on KTT strategies of scientific institutions?

Admitting that the knowledge and the technology transfer processes between universities and companies are complex and involve multiple factors (Perkmann *et al.*, 2013), this research focused on KTT strategies implemented by different players and their implications. To investigate the partnership through a strategic management view could enhance KTT literature. This partnership allows an understanding of the phenomena from multiple perspectives, and it might show the entities as dynamic and malleable actors (Nag *et al.*, 2007). An unplanned growth in literature can impede advancement by introducing competition and some counter-intuitive arguments in the scholarly dialogue (Kraus *et al.*, 2021). In this context, the study contributes to a clear understanding of the advancements and the state of knowledge stock in the field, enabling scientific institutions to select and adopt empirically validated KTT strategies.



Through a Systematic Literature Review (SLR), the paper aims to identify prominent publications about scientific institutions and their KTT strategies and to discuss their key findings. Assuming that SLR is a useful method to save researchers' time and effort in identifying paramount agenda (Webster & Watson, 2002), it is expected that this study could contribute to literature advance by suggesting investigations paths that could become avant-garde soon in the future. The SLR technique allows understanding the past since the synthesis of previous works helps to consolidate the existing literature in a certain field. At the same time, it aims to shape the future, offering the possibility of combining existing investigations with the creation of solid definitions and foundations for further research (Kraus *et al.*, 2020).

In addition to this introduction, the paper contains other five sections. In the methodology section, the procedures adopted for the sample selection and treatment are discussed. Afterward, the descriptive analysis part presents important characteristics (evolution of the research, prominent authors, main sources of publication, typology of studies, and location of research) of KTT strategies investigation. The fourth section describes and details the identified clusters. In the discussion section, the results are contrasted with previous literature, illustrating their main contributions to the subject. It also serves as an input for the proposition of an agenda for future investigations. Finally, the last section shows the conclusions, limitations, and contributions of the paper.

2 METHODOLOGY

To guarantee the study's replicability a systematic review process was followed. This technique generally conveys a greater sense of reliability about investigations in a research field (Petticrew & Roberts, 2006). Its purpose involves identifying, examining, and synthesizing all relevant studies carried out in a replicable and transparent process (Tranfield *et al.*, 2003). An SLR protocol was undertaken based on the guidelines proposed by Siddaway *et al.* (2019).

The protocol consists of:

1. Search strategy.
2. Study selection criteria.
3. Research selection procedures.
4. Data extraction strategy; and
5. Quality evaluation of the study.

Table 1 presents the elements considered for each stage of the protocol. The selection of the sample was delimited by articles published in English, on any date, from peer-reviewed journals in the fields of Management, Business, and Economics at the Web of Science (WOS) database (Malerba & Ferreira, 2020). WOS platform is the oldest and has the most coverage of journals and papers among the most used scientific databases (Vieira & Gomes, 2009).



Table 1

Systematic literature review protocol

Stage	Principle	Description
Search Strategy	Studies typification	Articles published in peer-reviewed journals.
	Keywords	Strategies; Education Institutions; Science Institutions; Universities.
	Search equation	("strateg*") AND ("education institution*" OR "science institution*" OR "universit*")
	Period	Until September 2020
Study selection criteria	Database	Web of Science
	Criteria	1) Class notes and book chapters were excluded 2) Conference articles were disregarded 3) Papers must be in English
	Procedures	1) Titles are selected 2) Abstract, introduction and conclusions sections were read 3) Full paper has been revised

Notes. Elaborated by authors.

KTT is complex and involves numerous activities (Tatikonda & Stock, 2003), as well as there are several synonyms for this expression (Cottrill *et al.*, 1989). The research focuses on strategies applied by individuals, scientific institutions, and public entities for the spread of knowledge. The term "strategy" was inserted in the database search field, and, afterward, papers that dealt with the intended topic were selected. By limiting the sample to studies with the terms in the title, only articles with a greater emphasis on the area emerged (Mascarenhas *et al.*, 2018).

Universities are the locus of excellence concerning knowledge and technology transfer activities (Curi *et al.*, 2012). For broadening the understanding of such phenomena, it is necessary to consider public and private institutions that emerged in the 19th century that are dedicated to helping startups to capture technology-based market opportunities, such as incubators and accelerators (Hausberg & Korreck, 2020). The investigation, then, used the Boolean connector "education institution*" OR "science institution*" OR "university*" to capture as much research as possible in this field.

Through search equations and filters, 134 studies were identified in the WOS database. After examining titles, abstracts, and keywords, 84 papers were rejected for non-compliance with the research objectives. Fifty investigations remained for an in-depth reading, including introductions and conclusions. In the end, 42 papers were aligned with the proposed goals, as shown in Figure 1.



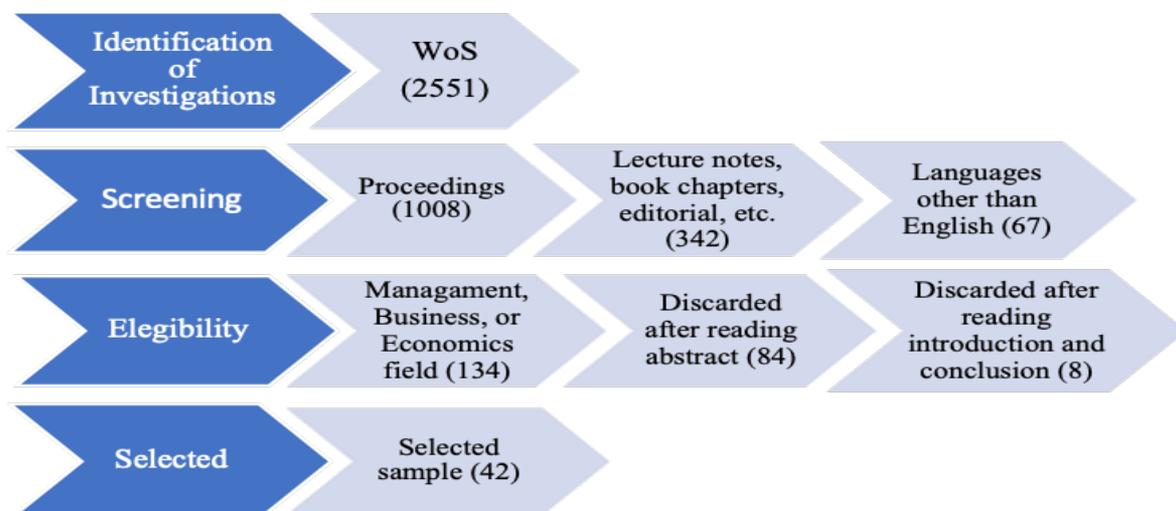


Figure 1. Sample selection process.
Notes. Elaborated by authors.

Limiting the scope of the investigation allows researchers to analyze a reasonable number of studies, identifying notable papers in the field, mainly authors, different methodologies, relevant contributions, and emerging trends. In this sense, the articles were divided into three clusters, following the approach of Deiacco *et al.* (2012), who suggests that research on KTT can be categorized according to the unit of analysis. Environmental Impact investigates the result of KTT policies on the environment surrounding scientific institutions; Institutional Effectiveness analyzes how scientific institutions, as autonomous and independent businesses, innovate and adapt within a changing system; and Individual Strategies observes KTT activities from the perspective of active academics.

3 DESCRIPTIVE ANALYSIS

3.1 Evolution of the research

The first contributions to literature are from the year 1998. When considering the decades of publications, it is possible to note, from Figure 2, a concentration of papers between 2011 and 2020. This decade gathers approximately 74% of all publications, showing that it is a contemporary topic. In the case of citations, the most relevant articles were published between 2000 and 2003, when only 04 papers were responsible for more than 43% of total citations.

Figure 3 shows a research trend reversal in the last five years. Scientific production migrated from analyzing the impacts of KTT strategies on the external environment to study factors that could enhance (or mitigate) the effectiveness of KTT strategies within research institutions. Although marginally, there is also an increase in papers focused on individuals' strategies for knowledge and technology dissemination.



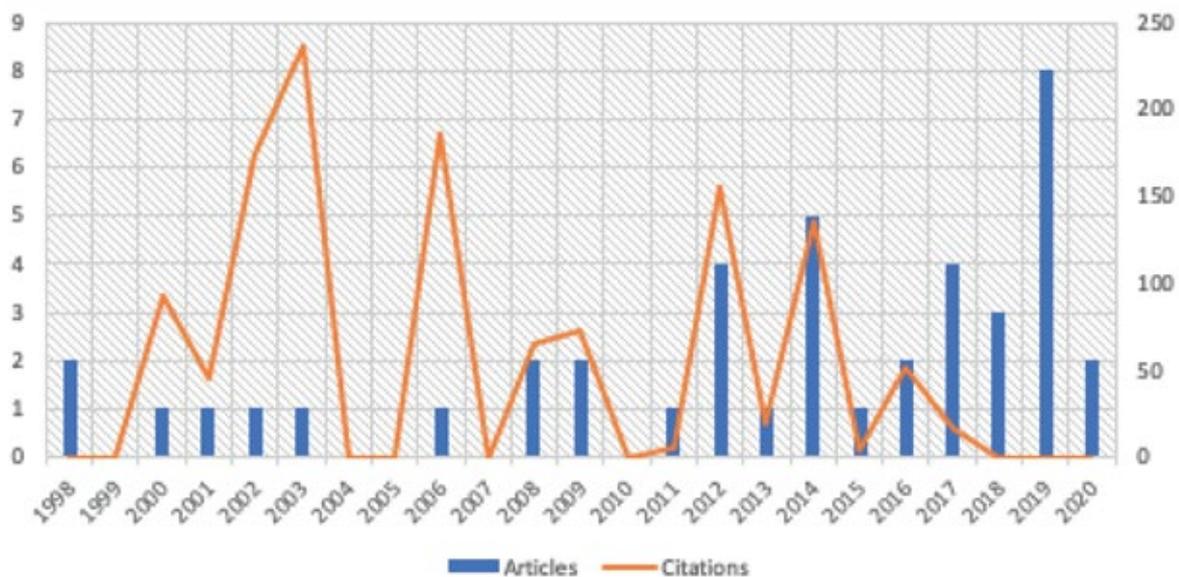


Figure 2. Articles and citations by year.
Notes. Elaborated by authors.

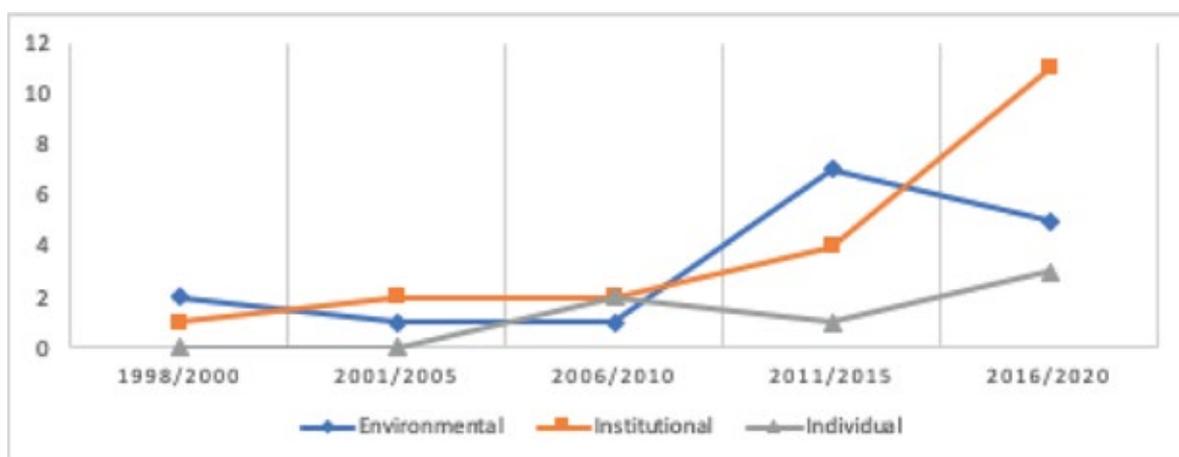


Figure 3. Articles evolution by cluster per 5-year period.
Notes. Elaborated by authors.

3.2 Prominent authors

There is a diversity of authors who contributed to literature. In all, 106 researchers were involved in the 42 investigations on KTT strategies in scientific institutions, what represents an average of 2,5 authors per article. Mike Wright (3), Alan Hughes (2), David Urbano (2), Elias G. Carayannis (2), Maribel Guerrero (2), and Shiri M. Breznitz (2) are the scientists with most published work in the field. Table 2 presents top-3 most cited authors (with ties) according to each approach.



Table 2

Top-3 most cited authors by cluster

Cluster	Author	Citations
Environmental	Alan Hughes	131
	Carayannis, Alexander and Ioannidis	92
	Michael Kitson	80
Institutional	Mike Wright	258
	Lockett and Franklin	237
	Feldman, Feller, Bercovitz and Burton	174
Individual	Ajay Agrawal	186
	Patzelt and Shepherd	54
	Guerrero, Herrera and Urbano	9

Notes. Elaborated by authors.

3.3 Principal sources

Twenty-eight journals published the articles in the sample and Table 3 shows the periodicals with at least 10 citations. *Technological Forecasting and Social Change* was the main disseminator of scientific research in this field. Despite having published only one article, *Small Business Economics* has the greatest academic impact, largely because of Lockett *et al.* (2003) seminal paper. Using citations per article to measure academic impact, Table 3 demonstrates that a greater number of articles will not translate into breadth in the knowledge dissemination. Analysis of publication sources by cluster did not identify any pattern.

Table 3

Principal sources of publications and citations.

Journal	Article	Citations	Cit/Art
Technological Forecasting and Social Change	6	102	17,0
Technology Analysis & Strategic Management	3	31	10,3
Science and Public Policy	3	15	5,0
Management Decision	3	14	4,7
Technovation	2	139	69,5
Cambridge Journal of Economics	2	131	65,5
Journal of Engineering and Technology Management	2	13	6,5
Small Business Economics	1	237	237,0
Strategic Management Journal	1	186	186,0
Management Science	1	174	174,0
Journal of Product Innovation Management	1	56	56,0
Entrepreneurship Theory and Practice	1	54	54,0
IEEE Transactions on Engineering Management	1	46	46,0
Management Learning	1	30	30,0
Cambridge Journal of Regions Economy and Society	1	25	25,0
Industrial and Corporate Change	1	19	19,0
R&D Management	1	19	19,0
International Journal of Technology Management	1	12	12,0

Notes. Elaborated by authors.



3.4 Typology of the studies

The sample contains 4 (9,5%) theoretical papers and 38 empirical studies, including 17 (40,5%) qualitative, 16 (38,1%) quantitative, and 5 (9,5%) mixed methods investigations. Figure 4 depicts the evolution of different typology approaches over the years. Both qualitative and quantitative methods appear to have the same importance in KTT strategies investigations, with a more significant growth of quantitative research recently. Theoretical work has also been gaining relevance in the last years, in contrast to mixed approaches.

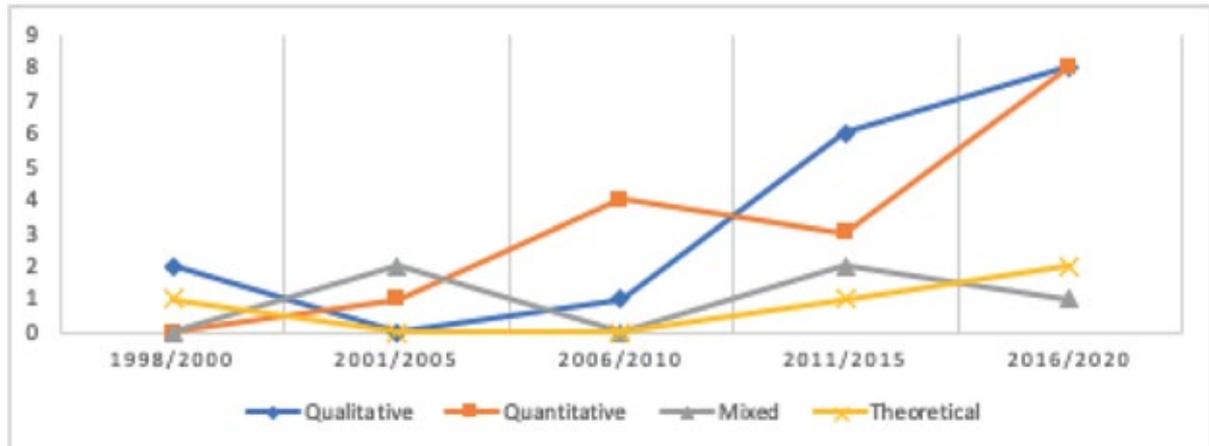


Figure 4. Investigations type by period.

Notes. Elaborated by authors.

Typology seems to vary according to the focus of study, as shown in Figure 5. Environmental research mainly used a qualitative approach (56,3%), followed by theoretical (18,7%), quantitative (12,5%), and mixed methods (12,5%). Papers belonging to Institutional cluster were developed in a quantitative (50,0%) perspective mostly. Qualitative (30,0%), mixed methods (15,0%) and theoretical (5,0%) comes next. Research elaborated within Individual cluster opted only for quantitative (66,6%) and qualitative (33,4%) approach when looking for empirical evidence.

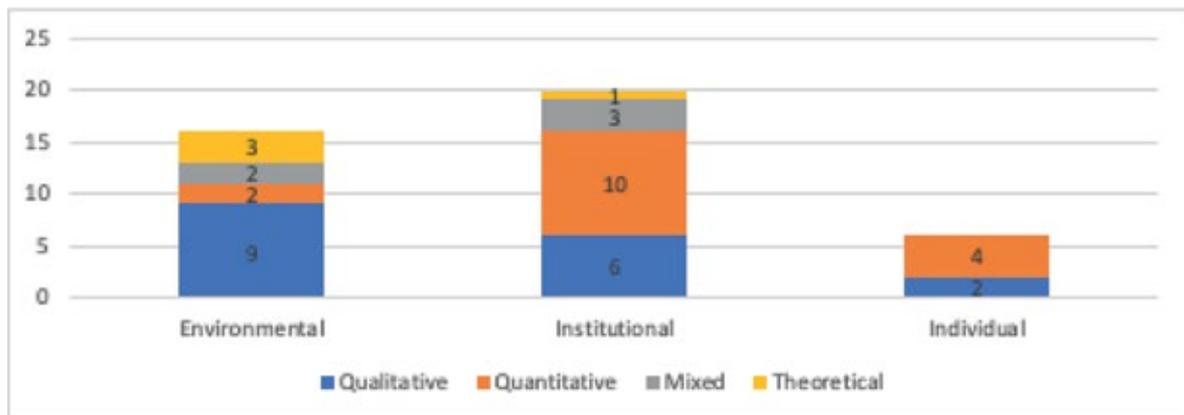


Figure 5. Investigations type in each cluster.

Notes. Elaborated by authors.

3.5 Research location

Considering the sample, 21 countries and 1 continent were the geographical focus of researchers. Among the regions most studied, the United Kingdom (10) and the United States (9) stand out as the places that had the greatest attention. These two countries account for 41,3% of all research in the field. Denmark, China, Canada, Norway, Spain, Germany, as well as Europe as a set, received 2 papers each. Most investigations were performed in developed countries (82,6%) in contrast with emerging (17,4%). This tendency is observed in Environmental and Institutional clusters, while research in Individual cluster were slightly less concentrated. Figure 6 presents results by study location inside clusters.

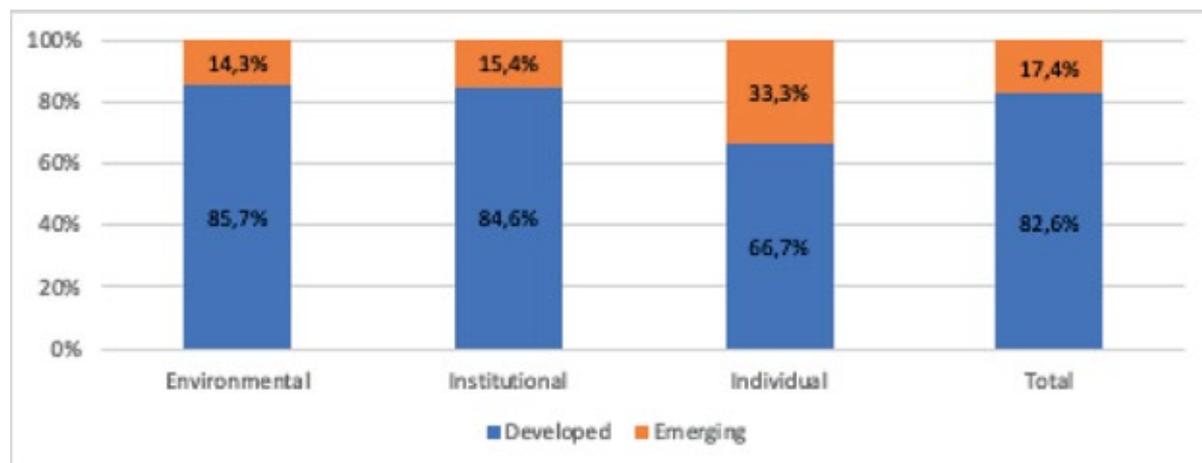


Figure 6. Research location by cluster.

Notes. Elaborated by authors.

4 CLUSTERS AND THEIR MAIN CONTRIBUTIONS

Based on Deiacó *et al.* (2012) approach, a deep analysis of the papers allowed to divide the sample into three different clusters, according to the focus of the research: i) *Environmental Impact*; ii) *Institutional Effectiveness*, and iii) *Individual Strategies*. Tables number 4, number 5, and number 6 present, for each work, the number of citations, typology of the investigation, the place where the research was undertaken, core analysis, and key findings.

4.1 Environmental Impact

The first cluster contains 16 papers that focus on the analysis of the impacts of science institutions' KTT strategies on external stakeholders, whether firms, other universities, government agencies, or geographic regions, as shown in Table 4. There is a global pressure for universities to engage in collaborative relationships with external partners to disseminate basic knowledge, applied technology, and promote R&D (Scott, 1998; Carayannis *et al.*, 2000). Companies establish cooperative strategies with universities to strengthen innovation, internationalization, access to cutting-edge technologies, and an improvement of human resources (Paranhos *et al.*, 2019; Santoro & Chakrabarti, 2001; Paton *et al.*, 2014). Nonprofit organizations and public administration can also benefit from alliances with research institutions through new initiatives, programs improvement, enhance competitive advantages, and fostering an innovative culture and ethics (Shaffer, 2012; Sharif & Tang, 2014).

Universities offer multiple engagement options that vary according to the institutional objectives of the partners (Frolund *et al.*, 2018; Bergenholtz & Bierregaard, 2014). The public agenda and the environment, however, might affect the behavior of academic institutions and their strategies for their financial outcomes. (Charles *et al.*, 2014; McCarthy *et al.*, 2018, Klofsten *et al.*, 2019; Breznitz *et al.*, 2008). Scientific institutions might contribute to the innovation efforts. Some universities mainly pursue a regional economic development agenda (Deiaco *et al.*, 2012; Giuri *et al.*, 2019). Literature, in turn, must expand the discussion of the impacts on university economics beyond science as a product to effectively assess the role of academic institutions in modern society (Hughes & Kitson, 2012).

4.2 Institutional Effectiveness

The largest cluster reunites 20 studies investigating different scientific strategies of institutions to improve the performance for spreading knowledge and technology. Table 5 summarizes the key aspects of the papers. The support offered by specialized units, like incubators and Technology Transfer Offices (TTO), creates competitive advantages for academic institutions, as these structures have positive effects on licensing commercialization, spin-offs performance, and universities' equity participation in new ventures (Bengtsson, 2017; Soetanto & Jack, 2016; Feldman *et al.*, 2002). These units' success depends on human resources quality, administrative autonomy, and alignment with parent university strategic priorities and objectives (Somsuk & Laosirihongthong, 2014; Mavi *et al.*, 2019; Pitsakis & Giachetti, 2020; Homer *et al.*, 2019; Aragonés-Beltran *et al.*, 2017).

The most successful universities on knowledge exchange have clear strategies toward the spinning-out of companies. They develop partnerships focused on R&D contracts, form broad alliances with diverse corporate partners, synchronize resource accumulation with growth strategies, and concentrate KTT activities on consultancy and personal development (Lockett *et al.*, 2003; Arvanitis & Woerter, 2009; Lubik *et al.*, 2013; Wright *et al.*, 2012; Pickernell *et al.*, 2019). It's paramount that this paper emphasizes that there is not only one formula that leads to KTT effective outcomes (Bergal-Mirabent *et al.*, 2020). The strategies must be tailored to the context (Özel & Pénin, 2016; De Moortel & Crispeels, 2018), as virtual teaming, exclusivity agreements, and proprietary forms of intellectual property (Hazlett & Carayannis, 1998; Van der Berghe & Guild, 2008; Andersen & Rossi, 2011). For instance, it could leverage universities' results. By exploring contrasting scenarios on KTT strategies, a clear picture is provided regarding the competitive advantages the strategic knowledge transfer positioning offers. (Robertson *et al.*, 2019).

4.3 Individual Strategies

The third cluster consists of 6 articles dedicated to investigating KTT strategies, as presented in Table 6. Universities, companies, and the public sector could lead the scientists to enhance the probability of technology commercialization success by providing incentive compensation, engaging inventors in products development, and creating policy programs that facilitate access to financing new ventures (Lee, 2017; Agrawal, 2006; Patzelt & Shepherd, 2009). The influence of such stakeholders on individual behavior, however, has a limited capacity. The research groups are driven neither by policy rhetoric nor institutional statements. But by personal qualities and interests of group leaders (Kirs *et al.*, 2017).

Relationships between academic faculty and private firms are complex. On the one hand, alliances established through consulting and applied research are critical for the new technologies' development (Chandran *et al.*, 2015). On the other hand, apprehension of opportunistic behaviors creates obstacles to the knowledge dissemination process and increase cooperation management costs during the early stages (Guerrero *et al.*, 2019).



Table 4
Environmental Impact

Authors (Year)	Cit.	Method	Research Country	Core Analysis	Key Findings
Scott (1998)	0	Theoretical	-	Develop principles that will guide the reinvention of the research university.	There is an increasing shift to look to the university to engage in a partnership focused on precompetitive research to develop the most important basic knowledge. A key factor in ensuring quality at the university is to stress the areas of strength.
Carayannis, Alex-ander, & Ioannidis (2000)	92	Qualitative	Germany, United States and France	Strategic management skills which firms must develop to participate in win-win alliances. GUI alliances.	Global pressures on national and corporate innovation provide motivation for collaborative efforts, indicating that the globalization of R&D has impact across nations. The design of GUISPs is influenced by the history and structure of the science in each company.
Santoro & Chakrabarti (2001)	46	Mixed	United States	Industry's strategic objectives for establishing relationships with university research centers.	The fit between the firm's strategic objectives and the nature of a university center determines the decision for establishing I/U relationships. Firms join university-based consortia to be privy to cutting-edge technologies, emerging trends, and best practices.
Brenzitz, O'Shea, & Allen (2008)	56	Qualitative	United States	Universities' technology transfer policies and their associated economic development impact.	Low support-low selectivity policies are more suitable to entrepreneurially developed environments, whereas high support-high selectivity policies are more efficient in entrepreneurially underdeveloped environments.
Schaffer (2012)	3	Mixed	United States	Evaluation of a tailored Nonprofit and University strategic partnership.	The initiative has the potential to be a win/win for university and nonprofit organizations as they use their collective resources to address important issues, improve programs, or create initiatives.
Delaco, Hughes, & McKevey (2012)	51	Theoretical	-	Universities as strategic actors and competitors in the knowledge economy.	It is important to keep a sense of what universities can contribute to the overall innovation effort and what their strategic role can be. Their strategic role will be intimately linked to the performance of other connected elements in the innovation system.
Hughes & Bergenholtz (2012)	80	Quantitative	United Kingdom	Implications of the policy discourse on the strategic role of universities.	It is essential to widen the discussion of economic impact and the strategic role of universities beyond the commercialization of science and technology transfer.
Bergenholtz & Bjerregaard (2014)	4	Qualitative	Denmark	Varying institutional conditions impact the U network-formations and search strategies.	The research processes and network formations of a high-tech small firm are shaped by different institutional conditions within which they are embedded. The significance of weak and strong ties is relative to varying institutional conditions, in general high-tech vs. life sciences universities' focus.
Charles, Kitagawa, & Uyara (2014)	25	Qualitative	United Kingdom	Shift in universities' strategic roles in economic development from regional to city levels.	Universities' strategies and behaviors have been shaped by national policy agendas and funding mechanisms. These changes are affecting different dimensions of activities of universities.
Paton, Chia, & Burt (2014)	30	Qualitative	United Kingdom	Examine the strategic partnership between a corporation and a university in an executive education program.	A true university/industry nexus emphasizes a collaborative client-centered relationship in which university business schools challenge and work with their client corporations to refine and redefine what is essential to the latter's sustainable success.
Sharif & Tang (2014)	12	Qualitative	China	The contribution of Hong Kong universities to the development of innovation-based industry.	There is no pattern of university-industry-government collaboration. Specific competitive advantages drive collaboration with institutions and firms. Academics will benefit from their culture of internationalization and professionalism in transferring research-related practices, culture, and ethics.
McCarthy, Nordentlicht, & Breznitz (2018)	5	Qualitative	-	How University Research Parks' strategies can vary to generate URP internal and external strategic fit.	URPs have different strategies due to: (i) heterogeneity of the environment within a URP operators; (ii) differences in the internal capabilities, and objectives of the university; and (iii) differences in the experience, knowledge or competence of URP managers or management teams.
Frolund, Riedel (2018)	5	Qualitative	United States	Explore the factors that make U-I collaborations successful.	Universities offer a wide array of modes of engagement. Firms must articulate strategic goals for partnerships and then choose collaboration structures that align with those goals. They must also identify key performance indicators to evaluate the partnerships.
Giuri, Mura, Scandura, & Toschi (2019)	8	Quantitative	Europe	Determinants of universities' strategic choices in the field of knowledge transfer.	Generalist and low prestige universities mainly pursue the local development strategy, while specialist and high prestige ones are more oriented towards the income generation strategy.
Paranhos, Meraçadante, & Soares (2019)	1	Qualitative	Brazil	Analyze strategies and organizational forms used by companies in interaction with universities for the development of innovation.	Companies are effectively using strategies for partnerships with universities through the creation of innovation departments, the establishment of internal scientific committees and the internationalization of research and development.
Klofsten <i>et al.</i> (2019)	26	Theoretical	-	Illustrate how universities can act strategically to become effective economic and societal change agents.	The concept of entrepreneurial university has many different meanings depending on the academic context. The local environment could have a strong impact on attitudes toward entrepreneurship and choice of external partners for research collaboration.

Notes: Elaborated by authors.



Table 5
Institutional Effectiveness

Authors (Year)	Cit.	Method	Research Country	Core Analysis	Key Findings
Hazlett & Carayannis (1998)	0	Qualitative	United States	Business-university teaming impacts on strategic planning.	Virtual teaming can develop new decision-making processes to help managers change direction as the environment changes; and do all this in real-time so that the organization can move at the right strategic moment.
Feldman, Feller, Bercovitz, & Burton (2002)	174	Mixed	United States	Mechanisms available to universities in managing the commercialization of intellectual property.	University's use of equity is a function of factors related to the university's prior experiences with licensing, success relative to other institutions, and the organization of the technology transfer office, as well as structural characteristics.
Lockett, Wright, & Franklin (2003)	237	Quantitative	United Kingdom	Strategies to promote the creation of spin-out companies.	The more successful universities have clearer strategies towards the spinning out of companies, the use of surrogate entrepreneurs in this process, and to possess a greater expertise and networks. The role of the academic inventor was not found to differ between the more and less successful universities.
Van der Bergh & Guild (2008)	9	Quantitative	Canada	Perceptions of the strategic value of new university technology and its impact on exclusivity agreements.	Licensing transactions are secured by exclusivity agreements when the use of new university technology enabled by the new university technology is new-to-the-firm or new-to-the-market and the firm's perception of the strategic value of the technologies is high.
Arvanitis & Woetter (2009)	19	Quantitative	Switzerland	Impacts of different strategies for KTT on innovation performance.	Strategies related to the "core" transfer activities such as R&D contracts are stronger correlated with innovation performance compared to strategies related to "softer" transfer forms.
Andersen & Rossi (2011)	6	Quantitative	United Kingdom	Different forms of Intellectual Property transfers, and its effectiveness.	Proprietary forms of IP are relatively more used in generating financial benefits to universities, while non-proprietary forms of IP are relatively more used in enhancing the flows of knowledge, fostering the innovation processes.
Wright, Clarysse, & Mosey (2012)	21	Qualitative	-	Resources and competencies selection and orchestration strategies to generate returns from USOs.	Adequate resource accumulation, the bundling of resources to build competitive and the leveraging of competencies into the market are necessary, but they need to be synchronized with growth strategy to realize sustainable growth of spin-offs.
Lubik, Garnsey, Minshall, & Platts (2013)	19	Qualitative	United Kingdom	Identify partnerships that are being pursued by those achieving greater than average commercial success.	Most commercially successful USOs formed alliances with corporate partners, so limiting their dependence on a single partner, in addition to a wide range of organizations including nonparent universities and other USOs.
Somsuk & Laosirihongthong (2014)	64	Mixed	Thailand	Enabling factors influencing the success of university business incubators (UBIs)	In promoting the success of UBIs, the management team needs to devote their efforts to monitor and manage enabling factors that have the highest priority. Human resources, especially in recruiting and developing managers, should be emphasized first and most.
Özel & Pénin (2016)	4	Theoretical	-	Understand the strategy and the performance of the transfer according to the nature of the invention.	University licensing strategies must be tailored to the context. In some cases, exclusive licensing maximizes social welfare. In other, more open strategies, based on publication, dominate. The university, to maximize its profits, may not always adopt the licensing strategy that maximizes social surplus.



Authors (Year)	Cit.	Method	Research Country	Core Analysis	Key Findings
Soetanto & Jack (2016)	47	Quantitative	United Kingdom, Netherlands, and Norway	Identify how incubation support and innovation strategy can determine the performance of academic spin-offs.	Incubation support has a positive effect on the performance of spin-offs; a market growth strategy has a positive effect on performance while a product development strategy has little effect on performance.
Bengtsson (2017)	9	Quantitative	Denmark, Sweden, and Norway	Analyze the effects of the introduction of the university ownership technology transfer (IPR).	The use of commercialization strategies, licensing, and spin-offs, is indirectly influenced by the IPR framework, and more directly by the policy intent of the university, the government funding system, the TTOs access to business development resources and competence.
Aragonés-Beltran, Poveda-Bautista, & Jimenez-Saez (2017)	8	Mixed	Spain	Analyze to what extent the offices are aligned with the university objectives.	The Development of a decision-making tool that helps TTO managers analyze the effectiveness of TTO activities and their degree of alignment with the institution's objectives.
De Moorrel & Crispeels (2018)	4	Qualitative	China, Europe, and United States	Framework on the international technology transfer between universities.	Chinese perspective is to enter international TT collaborations formally and with resource commitments, while Western perspective suggests informal entry without the creation of a new entity. Western perspective encourages formal structures over time, through commitment of resources and collaborative learning. Chinese perspective embraces the reduction of formal structures when increased confidence and trust.
Mavi, Gheib-doust, Khanfar & Mavi (2019)	4	Quantitative	Iran	Identify the factors influencing strategic management of university business incubators.	Human resources are the most-important factor, followed by technological, financial, and organizational resources. Talented managers and employees are the backbone of all organizations and incubators.
Pickernell, Ishizaka, Huang, & Senyard (2019)	1	Quantitative	United Kingdom	Explore the Knowledge Exchange (KE) strategy of universities in relation to their portfolio of KE activities.	Entrepreneurial universities valorize university knowledge through change (KE) strategy of universities: consultancy, personal development, softwares in relation to their portfolio ware license income and contract research.
Homer, Jayawarna, Giordano, & Jones (2019)	3	Quantitative	United Kingdom	Examines the relationship between strategic planning and technology transfer effectiveness.	It is the alignment between strategic choices made by university managers and the supporting organizational infrastructure that accounts for variations in technology transfer effectiveness. Universities that engage a wider number of faculty in strategic planning efforts benefit most.
Robertson, McCarthy, & Pitt (2019)	4	Qualitative	Canada, Malta, and South Africa	Understanding how social capital in UI partnerships affect knowledge transfer strategies.	By exploring contrasting settings on the knowledge transfer strategy framework, a clearer picture is provided regarding the competitive advantages – or lack thereof – that the strategic knowledge transfer positioning offers.
Berbegal-Mirabent, Gil-Do-menech, & De La Torre (2020)	0	Qualitative	Spain	Analyze how different patterns of production factors consumption led to specific technology transfer outcomes.	There is no unique formula of resource consumption that leads to a specific portfolio of TT outcomes. Universities must resort to internal intangible resources or inimitable combinations of the available resources to develop competitive advantages.
Pitsakis & Giachetti (2020)	0	Quantitative	United Kingdom	Propensity to imitate peers when designing commercialization strategies.	There is a negative relationship between Technology Transfer Offices' (TTO) autonomy and their level of imitation of the most successful TTO's strategy, and this relationship is moderated by the TTO's age and by their membership into an association where the benchmark TTO is also a member.

Notes: Elaborated by authors.



Table 6
Individual Strategies

Authors (Year)	Cit.	Method	Research Country	Core Analysis	Key Findings
Agrawal (2006)	186	Quantitative	United States	Engaging the inventor to increase commercialization success.	Strategies that involve engaging the inventor favorably influence the likelihood and degree of commercialization success.
Patzelt & Shepherd (2009)	54	Quantitative	Germany	How entrepreneurs perceive the usefulness of policy programs aimed at facilitating the development of academic ventures.	Access to finance offered by a policy program enhances the entrepreneurs' perceived benefits of other policy measures such as providing access to nonfinancial resources (networks, business knowledge) and reducing administrative burdens, but diminishes the perceived benefits of offering tax incentives for new ventures.
Chandran, Hayter, & Strong (2015)	4	Quantitative	Malaysia	Impacts of personal strategic alliances in research productivity of faculty and human capital development	Educational attainment, location at a designated research faculty publication productivity. Alliances established through consulting, applied research, and entrepreneurial experiences are critical for the development of new technologies.
Kirs, Karo, & Lumi (2017)	0	Qualitative	Estonia	Adaptation of strategic behaviors to respond to the policy rhetoric of the entrepreneurial university.	The strategic behavior of research groups is driven not by the policy rhetoric of the entrepreneurial university, but by the personal qualities and interests of group leaders and incentives and routines created by the longer-term development of the overall research funding system.
Lee (2017)	6	Quantitative	Korea	Identifying strategic human resource management practices to improve commercialization in universities.	The human resource management practices of providing incentive compensation to academic faculty, and the employment security and size of human resources in the industry liaison offices contribute to the university-industry collaboration performance.
Guerrero, Herrera, & Urbano (2019)	9	Qualitative	Mexico	Analyze how behaviors within university-industry partnerships are influencing the implementation of strategic knowledge management practices.	Behaviors effects represent an increment in the knowledge management costs during the monitoring stages. The <i>ex-ante</i> collaboration agreement protected intellectual capabilities. Knowledge management helps partnerships to moderate the effect of dual behaviors (collaborative and opportunistic) on the expected intellectual outcomes.

Notes: Elaborated by authors.



5 DISCUSSION AND RESEARCH AGENDA

The scientific reviews enable better identification of state of the art, which concerns the KTT strategies in scientific institutions. The researchers have a consensus that knowledge and technology dissemination strategies have a positive impact on society. It adds to the creation of new businesses, products, and services for the market. KTT strategies could expand the collective resources to address issues, improve programs, and create new brand initiatives. In addition to that, universities offer a wide array of engagement modes. The companies help to build new strategies for departments of innovations and the establishment of internal scientific committees. Successful KTT strategies favorably influence the spinning out of startups, the likelihood of technological commercialization, faculty publication productivity, and Intellectual Property registration. Such a strategy generates financial benefits to scientific institutions and fosters innovation processes and the development of new technologies. Some points, however, need further analysis yet, such as the role that the scientists play in developing products based on technology (Schaffer, 2012; Frolund *et al.*, 2018; Paranhos *et al.*, 2019; Lockett *et al.*, 2003; Andersen & Rossi, 2011; Agrawal, 2006; Chandran *et al.*, 2015).

A good strategy for alignment is an essential factor to maximize the results of KTT activities between scientific institutions, private corporations, and governments. More important than the amount of physical and financial resources available to participants in technology transfer networks is knowing why to integrate this networking and which specific network an agent should connect. An option for being part of the tech transfer processes must be taken through a strategic analysis of the benefits and challenges that such collaborative activity will provide for the participants. There must be a clear KTT strategy along with predetermined objectives and goals to achieve optimal results (Santoro & Chakrabarti, 2001; Lockett *et al.*, 2003; Sharif & Tang, 2014; Frolund *et al.*, 2018, Paranhos *et al.*, 2018).

In addition to that, the importance of human resources for effective KTT strategies must be considered. The human capital directly involved in KTT activities, going from knowledge creation to the management of support organisms, is a key resource for sound results. Institutions that seek to be at the frontier of innovation networks must improve and involve their best professionals throughout the process of strategic planning, management and control of knowledge and technology activities. There are solid indications that financial compensation, job stability, infrastructure of support and funding have direct impact on attracting qualified researchers (Hazlett & Carayannis, 1998; Somsuk & Laosirihongthong, 2014; Chandran *et al.*, 2015; Soetanto & Jack, 2016; Mavi *et al.*, 2019).

Despite notable advances in literature, there is still a long way to go. First, it must be recognized that the geographical, social, institutional, political, and economic contexts have a profound impact on the effectiveness of KTT strategies in scientific institutions. In other words, one cannot expect a solution to emerge along a *one size fits for all* approach (De Moortel & Crispeels, 2018; Klofsten *et al.*, 2019; Berbegal-Mirabent *et al.*, 2020).

Second, there are still doubts about the impact of the researchers' engagement in the entrepreneurial phase of the technologies they collaborated to develop. How can they contribute when the technology hits the market? Should scientists have a role in the management of the company, or should they act as technical consultants? These are questions where there are still no answers clarified by literature in the field (Lockett *et al.*, 2003; Agrawal, 2006; Pickernell *et al.*, 2019).

Finally, there are critical papers to a strictly commercial approach regarding KTT strategies. In view of the importance of the phenomenon for socioeconomic development and the complexity that involves the dissemination of knowledge, it is necessary to adopt other lenses to analyze in depth the different nuances of the problem, recognizing scientific institutions as a heritage of society (Deiaco *et al.*, 2012; Hughes & Kitson, 2012; Charles *et al.*, 2014).



Despite all this set of relevant conclusions reached by literature, there are yet some gaps that need further attention from the researchers in the field. Thus, the present study proposes a future research agenda to promote the advancement of understanding about KTT strategies. Table 7 contains twelve research questions, divided among the three clusters, which can serve as a guide for further investigations in the theme. The proposals were based on issues where there is still no consensus in the scientific community; in the context of declaration of emergency in public health of international importance by the World Health Organization, because of the COVID-19 pandemic; and, finally, on topics that demand current attention from researchers, such as climate change and immigration crises.

Table 7
Proposed future research agenda

Cluster	Research Question
Environmental Impact	What are the non-economic impacts, such as maintenance of immaterial and historical-cultural heritage, of KTT activities in society?
	What KTT strategies are being implemented by emerging countries to reduce the development gap in relation to wealthy countries?
	What are the impacts of KTT strategies in worldwide problems, such as global warming, immigration crisis and public health pandemics?
	How can different KTT strategies contribute to the improvement and effectiveness of public policies?
Institutional Effectiveness	How can scientific institutions improve KTT performance metrics to include non-economic goals?
	Which KTT strategies adopted by scientific institutions located in developing countries can overcome barriers and restrictions imposed by a challenging external environment?
	Which KTT strategies are effective in remote work and social distancing contexts?
	What are the impacts of different KTT strategies in increasing scientific institutions credibility and consequent reduction in the spread of fake news?
Individual Strategies	How to engage researchers from different areas of scientific knowledge, such as social, natural, philosophical, and artistic sciences, in KTT activities?
	How do professors feel about superior pressure to reconcile their teaching mainstream activities with KTT activities?
	What role should researchers play in the businesses that emerge after the development of new technologies?
	Do students feel pressured to integrate projects or develop KTT activities defined by professors, even if they are not in an area of interest?

Notes. Elaborated by authors.

6 CONCLUSION

The objective of the present study is to understand the current state of the academic debate regarding knowledge and technology transfer strategies in scientific institutions. Through a Systematic Literature Review it was possible to identify the advances and consensus reached by most prominent research in the field, undertake a descriptive quantitative analysis of relevant publications, and recognize avenues that have not been explored or that lack more empirical evidence to pacify controversies on certain issues.

Literature might be segmented according to the macro, meso or micro level approach of authors, enabling the emergence of three main research clusters. They regard the focus on each study: environmental impact, institutional effectiveness, and individual strategies. The quantitative



analysis of the sample allows to infer that this is a recent topic in which the current decade brings together approximately 74% of all publications. In addition, there is a trend of reversal in the focus of investigations, with the research in the last five years focusing on institutional analysis to the detriment of the environmental one. Regarding the typology of studies, qualitative and quantitative works have practically the same importance among the authors in this field. It is also worth noting the need for decreasing the geographic concentration of research in KTT strategies, given that almost 85% of the studies focused on develop countries.

From the literature review it was possible to highlight relevant results of KTT strategies in scientific institutions. Successful strategies can leverage innovation processes, generating greater financial benefits for scientific institutions through Intellectual Property contracts. In addition, they increase the likelihood of product's commercialization, the productivity of faculty engaged in technological development and the performance of startups that have gone through the incubation process and resulted in spin offs.

An effective knowledge and technology transfer policy is only possible, however, from the alignment of these activities with the strategic objectives of the institutions involved in innovation networks. Besides, the most important resource in the development and application of efficient KTT strategies is human capital, which must be properly selected, trained, and engaged in the entire process of knowledge dissemination to society. Finally, the different existing technology commercialization strategies must be adapted to socioeconomic contexts of the actors involved in the process, with no single or winning recipe for the transmission of knowledge.

Admitting the need to further the knowledge to deepen the process of the consolidation of the literature on KTT strategies in scientific institutions, a research agenda was proposed based on identified gaps. Such topics in previous studies did not reach a consensus on emerging themes in an increasingly digital, globalized, and dynamic world.

The results presented must be interpreted cautiously due to the limitations of the study. First, only one database was used. Although Web of Science is the platform that works with the most scientific publications, other relevant databases like Scopus were not consulted, limiting the study's range. The choice for only one database is because Vieira and Gomes (2009) found evidence that the most relevant studies are indexed in both platforms. Another limitation is due to the option to compose the sample only with papers written in English. Despite being the most used language in scientific publications (Sandelin & Sarafoglu, 2004), untranslated papers that were developed in Latin America, Continental Europe, Africa, and Asia were excluded from this analysis.

As the main contributions of the paper, they can be listed on three different fronts. In the methodological aspect, the implemented technique allows the replicability of the study by third parties to validate the results or the use of the research protocol in other databases to expand the knowledge in the field. By proposing a future research agenda, the work seeks to advance the development and consolidation of a theoretical framework on KTT strategies, illustrating research gaps that need a greater scrutiny by specialized literature. Finally, from a managerial point of view, this investigation contributes by systematically discussing the main results and impacts of different scientific institutions' KTT strategies, supporting the decision-making by leaders of these organizations in the search for efficient strategies for themselves.



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Every author should account for at least one component of the work. Paper approved for publication need to specify the contribution of every single author.

Contribution	[Author 1]	[Author 2]
1. Definition of research problem	√	
2. Development of hypotheses or research questions (empirical studies)	√	√
3. Development of theoretical propositions (theoretical work)		
4. Theoretical foundation / Literature review	√	√
5. Definition of methodological procedures		√
6. Data collection	√	
7. Statistical analysis	√	√
8. Analysis and interpretation of data	√	
9. Critical revision of the manuscript	√	√
10. Manuscript writing	√	√
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