



Journal of Innovation & Knowledge

<https://www.journals.elsevier.com/journal-of-innovation-and-knowledge>



Conceptual paper

Knowledge transfer in the context of inter-organizational networks: Foundations and intellectual structures

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ARTICLE INFO

Article history:

Received 26 June 2018

Accepted 16 February 2019

Available online xxx

Keywords:

Knowledge transfer

Inter-organizational networks

Bibliometrics

Co-occurrence

Co-citations

Bibliographic coupling

ABSTRACT

Organizational networks allow the creation and development of knowledge that can be transferred and shared among their components, with an impact on organizations' innovation and performance. Based on this perspective, this study is the result of research on scientific production related to knowledge transfer in the context of inter-organizational networks. Combining various bibliometric techniques, such as co-occurrence analysis, bibliographic coupling and co-citation of documents and authors, 102 articles on the topic published in the main database of scientific knowledge worldwide, *Web of Science*, were analyzed in detail. The results indicate that knowledge transfer, in the context of organizations, is a recent topic but one that is clearly expanding. Therefore, this subject has increasingly attracted the attention of researchers all over the world. This study also identifies the origins of the current literature on the subject, as well as its foundations and main intellectual structures. The analysis made also presents information that can serve as a basis for future investigators to project, aim for, and attain better results from their research efforts.

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Introduction

In recent years, researchers all over the world have increasingly concentrated their efforts on the process of knowledge transfer occurring in the context of inter-organizational networks. A possible explanation for this growing interest is the recognition that creation and control of the flow of knowledge, both inside and outside the bounds of the organization, are important factors for generating and maintaining organizations' competitive advantage (Argote & Ingram, 2000). In this connection, organizations' capacity to recognize the value of new external information, and get hold of it, is fundamental in developing their potential for innovation (Cohen & Levinthal, 1990).

Setting out from this statement, this study is the result of research on scientific production dealing with how knowledge is created and flows between participants in organizational networks. The aim is to fill an important gap in the literature, since there is a shortage of studies that have systematically reviewed the literature on the topic, adopting a well-defined protocol for the selection and analysis of sources (Cronin, Ryan, & Coughlan,

2008), and that have focused on this promising field of research, through the use of advanced bibliometric techniques. More specifically, this study aims to answer the following research questions: (i) What are the origins and evolution of scientific production on knowledge transfer in the context of organizational networks? (ii) What are the intellectual structures of scientific production on the topic? and (iii) What are the theoretical foundations originating research on the topic? Therefore, the study's objective is to systematize scientific production on knowledge transfer in the domain of organizational networks, through applying advanced bibliometric techniques, associated with a qualitative analysis of the contents of the international literature of greatest impact in the field.

This research is justified by the relevance of the subject, confirmed by the growth in the related scientific production and the lack of similar studies. Firstly, applying advanced bibliometric techniques, such as co-occurrence analysis, bibliographic coupling and analysis of co-citations from documents on the main work in the field provides an understanding of the history of the recognition and academic impact of publications, as well as the potential for use by future researchers (Hjørland, 2013). This study also advances and analyses the proposed topic from various points of view, through triangulation of various units of analysis. In complementary terms, it goes beyond the 102 documents in the sample and focuses on the joint work carried out by authors in the field.

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<https://doi.org/10.1016/j.jik.2019.02.001>

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In order to provide a logical portrayal, it was decided to present the content of the study as follows. The next section carries out a review of the literature associated with the phenomenon of knowledge transfer in the context of organizational networks. Then the criteria used in selecting articles are stated, as well as the techniques applied to analyze the database selected. This is followed by presentation of the results of the research, and finally, considerations of the work carried out and the implications of the results obtained.

Knowledge transfer in organizational networks

The growth of organizational networks has generated considerable interest in this topic among both academics and practitioners (Culpan, 2009; Shah & Ewaminathan, 2008) and they have grown in popularity over the last years (Augustine & Cooper, 2009). The principle studies making most reference to the subject of networks are those by Johanson and Mattsson (1987), Hakansson and Snehota (1989) and the research carried out by Easton (1994).

The creation of organizational networks is an increasingly common strategy to increase organizations' competitiveness (Franco, Haase, & Barbeira, 2015; Holmberg & Cummings, 2009; Inkpen & Beamish, 1997). Organizational networks can take various forms. For example, they can be horizontal or vertical, formed between competitors or clients-suppliers between domestic or international partners, or between firms and educational and research institutions (Álvarez, Marin, & Fonfría, 2009; Barbeira, 2012). In all these contexts, organizational networks have a great potential to create knowledge, which in turn can be transferred and shared between their elements to become a valuable strategic resource for modern organizations (Cozzarin & Percival, 2006; Das & Teng, 2000; Franco et al., 2015; Schmiedeberg, 2008; Tsai, 2001; Weber & Khademian, 2008).

According to Nonaka, Takeuchi, and Umemoto (1996), the creation of organizational knowledge is a process of amplifying the knowledge originally created by the individual and its crystallization as part of the organization's knowledge system, in a never-ending spiral of transforming tacit and explicit knowledge. As an organizational resource, knowledge differs from others due to some particular attributes, namely: (i) it is inexhaustible; (ii) it grows and increases through its share and use; and (iii) it needs continuous stimulation to avoid becoming obsolete (Passerini, 2007). From the results and/or objectives it leads to, knowledge represents an entry and exit resource. Knowledge is therefore defined as the main determinant of organizations' functioning, sustainable value and performance (Passerini, 2007).

For Nonaka et al. (1996), there are four ways of converting knowledge: (i) socialization (tacit to tacit); (ii) externalization (tacit to explicit); (iii) combination (explicit to explicit) and (iv) internalization (explicit to tacit). In this context, Barbeira (2012) explains that organizations should have the capacity to manage knowledge, handling its various dimensions creatively. For knowledge, often organizations' most valuable resource (Assudani, 2005), to be effective and transformed into value, it must be correctly contextualized, compiled, categorized, stored, spread and used, as well as possibly corrected and reused (Jarrar, 2002).

As Franco et al. (2015) explained, knowledge-sharing is a key concept in the knowledge management process, to the extent that various researchers have focused on identifying the stages involved, highlighting Nonaka (1994), Spender (1996), Teece (1998), Gold, Malhotra, and Segars (2001), Darroch (2003), Franco and Mariano (2007) and Law and Ngai (2008). Setting out from these studies, Franco et al. (2015) proposed that organizational knowledge management begins with the acquisition of knowledge, followed by its dissemination within the organization and the cycle

is closed with effective application of that knowledge in the organizational context.

In a broader sense, knowledge sharing is defined as activities of transferring or disseminating knowledge from one person, group or organization to another (Ipe, 2003; Lee, 2001). This definition contains an important facilitator for knowledge sharing, namely, social networks in which inter-organizational knowledge is shared. In this process, individuals serve as knowledge generators and receptors (Okyere-Kwakye & Nor, 2011). According to Barbeira (2012), organizational networks are mechanisms to promote social interaction which, through generating feelings of trust and reciprocal actions, allow the transfer of knowledge between their participants, as well as the rapid adoption of innovations.

In general, knowledge sharing represents a key concept within the knowledge management process. Here, organizing, structuring and combining knowledge are the main processes (Nahapiet & Ghoshal, 1998). Networks are particularly useful for sharing knowledge over the boundaries of an organization. Thus, direct contact among employees from different organizations should lead to a more efficient transfer of knowledge and subsequently higher absorptive capacity (Schmidt, 2010). Minbaeva, Pedersen, Bjorkman, Fey, and Park (2003) stated that the key factor in knowledge transfer is not the owner's original knowledge but rather the extent to which the receiver acquires that knowledge and uses it in operations. Nevertheless, organizations must acquire and internalize only potentially useful knowledge (Harrison & Leitch, 2005). In addition, organizations must possess so-called 'absorptive capacity', i.e., the ability to use prior knowledge to recognize the value of new information and create new knowledge from that information (Cohen & Levinthal, 1990).

Grant (1996a) also considers transfer as one characteristic of knowledge that is necessary to create value in the context of its use in an inter-organizational network. The transfer of knowledge is a complex process that depends, to a great extent, on organizations' characteristics, but also on the type of management they adopt (Siegel, Veugelers, & Wright, 2007). In this regard, Boal (2007) stresses that the transfer of tacit knowledge is promoted through strong social network ties, requiring a robust connection between the people involved. According to this author, knowledge dissemination expresses the organization's capacity to reuse existing knowledge and disseminate it throughout the organization.

Knowledge transfer appears to represent a significant factor for knowledge sharing in inter-organizational networks. Organizations should be aware that these networks can be an important way to access and transfer knowledge, and a way to absorb and create new knowledge (Janowicz-Panjaitan & Noorderhaven, 2008).

According to the Häkasson and Ford, 2002 model, it is natural and expected that knowledge, in the organizational network context, extends beyond the limits of each organization and flows through the network structures via its nodes (participating organizations) and lines (links between organizations). However, for knowledge to be effectively shared in the network, some conditions are necessary, such as the effective exchange of experience, cooperation, compatibility of organizational culture and motivation, as well as establishing strong relationships and cohesive groups, creating conditions for the formation of mutual trust among network participants (Barbeira, 2012; Soekijad & Andriessen, 2003). In this connection, Abdullah, Hamzah, Arshad, Isa, and Ghani (2011) indicated that knowledge transfer depends on the existence of a climate that promotes collaboration and trust, and on participants feeling rewarded for their effort.

Finally, the formation of networks allows diverse forms of cooperation and partnerships between organizations. In particular, knowledge sharing through inter-organizational social networks may lead to synergies and higher organizational efficiency. In fact,

networks can be a means to create and share knowledge, which is often interpreted as their main function.

Methodology

Selection of articles

As emphasized by Webster and Watson (2002), a literature review can adopt two approaches: (i) a review of topics on which there is already a great volume of accumulated knowledge, in which case the procedures of analysis and synthesis are useful; and (ii) a review of emerging topics on which the literature is not usually so extensive, in which case the main contribution is presentation of the potential theoretical bases. This literature review is set in the former perspective. Cronin et al. (2008) clarified that the technical procedure of researching articles can be based on two strategies: (i) a narrative or traditional review of the literature, a procedure that results in presenting the literature without explaining the criteria used in its selection; and (ii) a systematic literature review, which adopts a well-defined protocol for selection and analysis of sources. This study adopted the latter strategy. More specifically, it adopted a quantitative approach to analyze the literature on the proposed topic, mixing basic indicators with advanced bibliometric techniques. As underlined by O'Connor and Voos (1981), a bibliometric analysis can contribute to scientific knowledge by helping to explain the causes of the bibliographical phenomena related to subjects of scientific interest.

The articles gathered in the sample used for this study were identified by consulting the main database of scientific articles worldwide, *Web of Science*, specifically from the following indices: *Science Citation Index Expanded* (SCI-Expanded), *Science Citation Index Social* (SSCI), *Arts & Humanities Citation Index* (A & HCI), *Conference Proceedings Citation Index – Science* (CPCI-S), *Conference Proceedings Citation Index – Social Science & Humanities* (CPCI-SSH) and *Emerging Sources Citation Index* (ESCI). No categorical or chronological filters were applied. The terms of research used and applied to the titles, abstracts and key words were: “organizational network”, “knowledge transfer”, “knowledge sharing” and “knowledge management”. The Boolean operators “AND” and “OR” were used, combined to increase the coverage of the results and used as follows: “*organiza* network*” AND (“know* transfer*” OR “know* shar*” OR “know* management*”). The consultation was carried out on 29 April 2017 and resulted in 102 scientific articles published in journals and conference annals indexed on the *Web of Science* database, with publication dates between 1992 (1 article) and 2017 (5 articles, until the month of April).

Bibliometric analyses

The file containing the set of 102 studies was created directly on the *Web of Science* platform and exported to VOSviewer, version 1.6.5 software, allowing various bibliographic analyses based on the method proposed by Eck and Waltman (2009), Van Eck and Waltman (2010). More specifically, the following complementary bibliometric techniques were applied: (i) co-occurrence analysis, (ii) bibliographic coupling of documents and authors, and (iii) analysis of co-citations from documents and authors. In order to identify the principal specific issues dealt with in the set of 102 sample articles, a co-occurrence analysis of words and expressions was performed. For this, text-mining techniques were applied to the titles, abstracts and key words of the documents. Co-occurrence links are based on identifying multiple words or expressions occurring together in the same document. The relationship between items is determined based on the number of documents in which the words

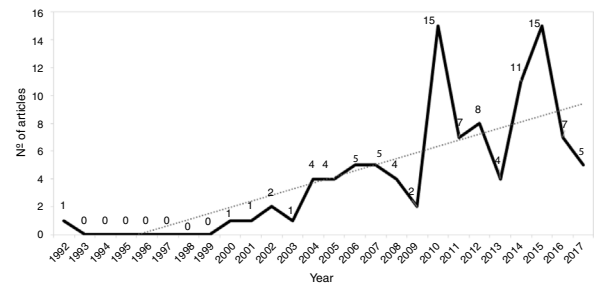


Fig. 1. Publications by year and tendency.

or expressions occur together (Van Eck & Waltman, 2010; Waltman, van Eck, & Noyons, 2010).

The bibliographic coupling technique was originally proposed by Kessler (1963) and is based on identifying references shared by two articles. That is, the existence of an item of reference common to two articles indicates they are bibliometrically coupled (Egghe & Rousseau, 2002). The strength of that link, or coupling, increases according to the number of references shared by the articles (Grácio, 2016). Application of bibliographic coupling allows a retrospective analysis of scientific production, considering that the strength of the link between the articles is fixed, rather than changing over time (Small, 1973). Therefore, considering that the set of references used in a study reflects the intellectual environment from which the researchers worked (Grácio, 2016), the bibliometric coupling technique allows identification of the nuclei of research, the researchers and the most important articles in a given field of research (Grácio, 2016). For Glänzel (2003), bibliographic coupling is one of the most efficient ways to view a scientific domain.

However, Grácio (2016) explains that bibliographic coupling has some limitations, as the technique is based on studying the links originally defined by the authors (citations), which allows only a partial vision of a field’s intellectual structure. Therefore, the author proposes that more thorough and complete bibliographic analyses should add another complementary technique: co-citation analysis. Proposed by Small (1973), co-citation analysis is a way to analyze the link between two articles based on the frequency with which those documents are quoted together. That is, the more often two articles are quoted together (co-citation), the stronger the link between those articles. Here, the strength of the bond linking two articles can grow over time, inasmuch as that link is dynamic and established later (Grácio, 2016). Analysis of links between pairs of documents through co-citations allows a description of the dependence existing between articles, researchers, fields and approaches. It is therefore possible to identify the strength of the link between documents, authors, themes, journals and countries (Grácio, 2016; Hjørland, 2002). That is, by examining the proximity of two researchers through how often they are quoted together by the scientific community, recognition of the intellectual and social structure constructed by that community is shown, independently of the perception of those co-cited themselves (Grácio, 2016).

Results and discussion

Description of the field

Fig. 1 indicates the beginning and illustrates the evolution of articles published on the topic of knowledge transfer in the context of inter-organizational networks. The information is provided by year, and reveals a clear growth of publications in subsequent years. The first study identified was Groenewegen (1992), which analyses the role of research and development networks in the Dutch context, involving universities and firms in the high-tech

Table 1
 Most cited articles.

Authors	Article title	Total of citations	Mean by year
Tsai (2001)	Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance	1090	64.12
Owen-Smith and Powell (2004)	Knowledge networks as channels and conduits: The effects of spillovers in the Boston biotechnology community	638	45.57
Tsai (2002)	Social structure of “coopetition” within a multiunit organization: Coordination, competition, and intraorganizational knowledge sharing	534	33.38
Scarborough (2003)	Knowledge management, HRM and the innovation process	96	6.40
Chung et al. (2004)	Networked enterprise: A new business model for global sourcing	65	4.64
Chiaroni et al. (2010)	Unravelling the process from Closed to Open Innovation: evidence from mature, asset-intensive industries	61	7.62
Dokko and Rosenkopf (2010)	Social capital for hire? Mobility of technical professionals and firm influence in wireless standards committees	55	6.88
Paruchuri (2010)	Intraorganizational networks, interorganizational networks, and the impact of central inventors: A longitudinal study of pharmaceutical firms	51	6.38
Thorgren et al. (2009)	Designing interorganizational networks for innovation: An empirical examination of network configuration, formation and governance.	47	5.22
Hartley and Benington (2006)	Copy and paste, or graft and transplant? Knowledge sharing through inter-organizational networks.	34	2.83

ceramic industry. The author indicated there were important differences between institutional networks (government bodies and universities) and business networks, and that government policies have a significant impact on academic researchers' activity, but do not have the same impact on research developed by firms. It was eight years after the publication of Groenewegen's study before the topic was revisited, with the work of [Van Aken and Weggeman \(2000\)](#). The authors discussed the nature and productivity of informal innovation networks, i.e., informal collaboration agreements between organizations involved in product or process innovation.

2001 was the year with the greatest stimulus for research on knowledge transfer in the context of organizational networks. More specifically, in this year, Professor Wenpin Tsai of Pennsylvania State University published the article *Knowledge Transfer in Intraorganizational Networks: Effects of Network Position and Absorptive Capacity on Business Unit Innovation and Performance*. [Tsai \(2001\)](#) has 1.090 citations made by studies on the *Web of Science* database, and according to that criterion, it is the most important article on the subject in this study. The author used the concept of absorptive capacity ([Cohen & Levinthal, 1990](#)) and the notion that an organization's position in a network influences the opportunities to access new knowledge ([Dougherty & Hardy, 1996](#); [Ibarra, 1993](#); [Van de Ven, 1986](#)) to carry out empirical research on the knowledge flow in a firm network in the oil sector. [Tsai \(2001\)](#) concluded that organizational units can produce more innovations and achieve better performance if they occupy central positions in the network, as this gives easier access to new knowledge. Nevertheless, that advantage will only be effective if they have developed the absorptive capacity to successfully replicate that new knowledge.

After [Tsai \(2001\)](#), the growth of publications on the topic was notable, with the two most productive years being 2010 and 2015, with 15 articles published each year. In 2017, up to April, 5 new studies became available to the scientific community. [Table 1](#) presents the 10 most quoted studies among the 102 in the sample studied.

Analysis of the scientific journals and conference annals publishing articles on knowledge transfer in the sphere of inter-organizational networks identified the North-American journal *Organization Science* (ISSN: 1047-7039; impact factor in 2015: 3.36) as the main channel for publishing work on the topic, with 9 articles (8.9% of the total). In total, 89 journals or conference annals published studies on the subject. [Table 2](#) presents the 10 most

Table 2
 Studies by source (number of studies published in brackets).

<i>Organization Science</i> (9)
<i>R&D Management</i> (4)
<i>Proceedings of the 8th European Conference on Knowledge Management Vols. 1 and 2</i> (3)
<i>Journal of Knowledge Management</i> (3)
<i>Journal of Business Research</i> (3)
<i>Expert Systems with Applications</i> (3)
<i>Lecture Notes in Computer Science</i> (2)
<i>Journal of Strategic Information Systems</i> (2)
<i>Journal of Engineering And Technology Management</i> (2)
<i>Journal of Business Industrial Marketing</i> (2)

Table 3
 Most productive institutions.

University	Country	Publications
Radboud University Nijmegen	Netherlands	4
University of Washington Seattle	USA	3
University of Washington	USA	3
University of Warwick	UK	3
University of Groningen	Netherlands	3
University of California System	USA	3
Tsinghua University	China	3
Eindhoven University of Technology	Netherlands	3
Beijing Jiaotong University	China	3

common sources, with at least 2 studies, which account for 32% of all scientific production in the field. As the other 79 sources published 1 article each, the distribution of work on knowledge transfer in the context of organizational networks can be considered very scattered.

Regarding universities' productivity, a Dutch institution leads the ranking for studies on the subject, with 4 publications: *Radboud University Nijmegen*. In the list, 8 institutions appear with 3 publications each, 3 North-American, 2 Dutch and 2 Chinese universities, as shown in [Table 3](#). Another 21 universities contributed 2 studies each. Finally, 110 institutions are in the ranking with one study each. In terms of national production, 4 countries are responsible for 66 studies, i.e., accounting for 64.7% of production worldwide. The United States is in first place with 26 studies (25.5%), followed by China with 16 (15.7%). Then come the Netherlands and the United Kingdom with 12 studies each (11.8%). The remainder of

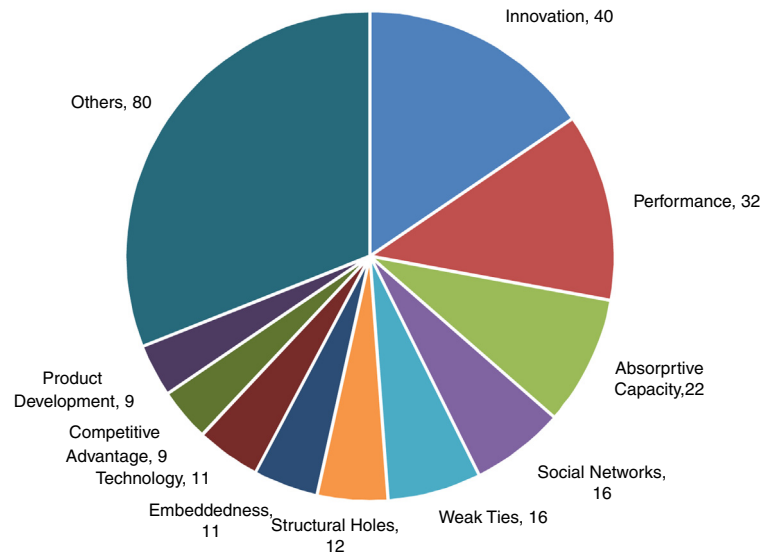


Fig. 2. Most frequent themes.

scientific production on the topic came from researchers in another 28 countries in all continents. Those results indicate that interest in the topic has increased significantly and that although recently introduced to the literature, knowledge transfer in the context of organizational networks is a diversified and promising field of research.

Structures of the field

In order to identify the matters most frequently addressed in studies on knowledge transfer in the organizational network context, the 102 studies in the sample were submitted to an analysis of word and expression co-occurrence. To do so, text-mining techniques were applied to the documents' titles, abstracts and key words. Words with a minimum of 5 occurrences were considered. In this way, the initial set of 563 words and expressions was reduced to 41. Then the related words and expressions were analyzed visually. The aim was to identify terms that should be excluded, such as indications of the names of countries, analysis techniques, the combination of words in the singular and plural, and identification of repeated terms. The sample was thereby reduced to 25 items. Fig. 2 presents the distribution of the themes most frequently mentioned in the 102 sample studies.

It should be highlighted that the most common theme in the studies was identified as being "innovation" (40 occurrences), followed by "performance" (32 occurrences). That is, the majority of studies made on knowledge transfer in the context of organizational networks is focus on understanding how knowledge flows and can be appropriated by network participants, with the aim of allowing organizations to create new processes, products or services, with direct consequences for organizational performance, as observed by Tsai (2011). Also underlined is the importance of the literature on networks, as shown by the presence of themes such as "social networks" (16 occurrences), "weak bonds" (16 occurrences) and "embeddedness" (11 occurrences) (Granovetter, 1973, 1985). Another significant finding is the importance of the literature on absorptive capacity (Cohen & Levinthal, 1990), mentioned 22 times and present since the work of Tsai (2001).

To identify the networks formed from the degree of similarity of the references used by the authors of the 102 articles in the sample,

the analysis technique of bibliographic coupling of documents was applied (Kessler, 1965). No cut-off criterion was established (for example, number of citations), considering that one of the advantages of this bibliographic coupling technique is precisely the possibility to analyze new work that has not had time to be quoted (Rehn, Gornitzki, Larson, & Wadskog, 2014). Considering that only 95 articles have mutual connections, i.e., sharing at least one study in their list of references, 7 articles were withdrawn. Fig. 3 presents the map formed through bibliographic coupling of documents, with visual indication of clusters by colour. That division suggests there are thematic, theoretical or conceptual similarities that differentiate articles in one group from those in the others (Egghe & Rousseau, 2002; Zhao & Strotmann, 2008). The studies are represented by the circles (nodes) of the network. The size of the nodes is proportional to the number of citations from each study and the studies' proximity or distance in the network indicates to what extent they are coupled bibliographically, i.e., the presence of two studies that are physically very close indicates they share a good deal of their set of references.

Application of the technique of bibliographic coupling of documents indicated that the set of studies can be divided in three groups. The first cluster, indicated in red, is formed of 39 documents which, in general, analyze the organization especially from the perspective of processes of innovation and organizational change and the risks of knowledge leaking outside organizational boundaries. The second cluster (green) covers the 32 studies mostly concerned with network configuration and member-organizations' capacities to absorb and spread knowledge. Finally, the third cluster (blue) is the result of grouping 24 documents that focus on analyzing the role of individuals in networks and organizations, dealing especially with topics such as human capital and social networks, as well as network management and governance. Table 4 presents the 95 studies analyzed and their respective clusters.

Aiming to extend knowledge of the structures of the literature on knowledge transfer in the network context, the technique of bibliographic coupling of authors was also applied (Zhao & Strotmann, 2008). This gives a truer and deeper view of a scientific domain, especially when used together with other bibliometric techniques such as bibliographic coupling of documents and

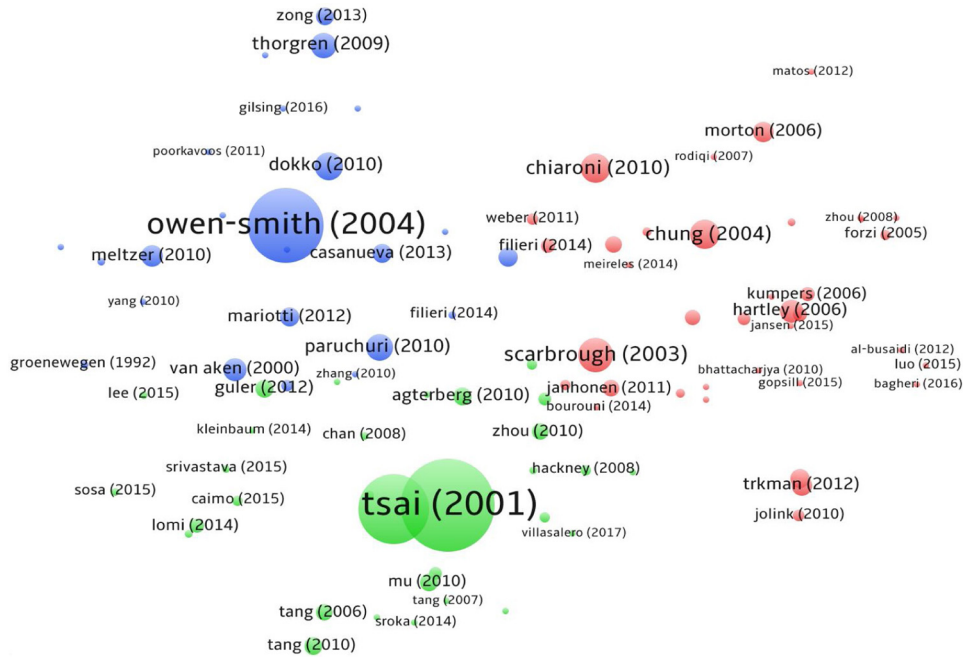


Fig. 3. Map of bibliographically coupled documents with clusters.

Table 4
 Articles, clusters and citations.

Cluster 1		Cluster 2		Cluster 3	
Article	Citations	Article	Citations	Article	Citations
Scarbrough (2003)	96	Tsai (2001)	1090	Owen-Smith and Powel (2004)	638
Chung et al. (2004)	65	Tsai (2002)	534	Dokko and Rosenkopf (2010)	55
Chiaroni et al. (2010)	61	Guler and Nerkar (2012)	20	Paruchuri (2010)	51
Hartley and Benington (2006)	34	Agterberg et al. (2010)	20	Thorgren et al. (2009)	47
Trkman and Desouza (2012)	21	Tang et al. (2010)	18	Van Aken and Weggeman (2000)	33
Morton et al. (2006)	26	Mu et al. (2010)	18	Meltzer et al. (2010)	31
Mirabelli and Newell (2012)	21	Tang et al. (2006)	16	Casanueva et al. (2013)	22
Janhonen and Johanson (2011)	16	Zhou et al. (2010)	15	Mariotti and Delbridge (2012)	22
Hutzschenreuter and Horstkotte (2010)	16	Lomi et al. (2014)	10	Bellamy et al. (2014)	21
Muller-Seitz (2012)	12	Tang (2011)	9	Zong et al. (2013)	19
Jippes et al. (2012)	11	Patriotta et al. (2013)	8	Ghosh and Rosenkopf (2015)	6
Kumpers et al. (2006)	11	Caimo and Lomi (2015)	5	Gluckler and Panitz (2015)	3
Filieri et al. (2014)	10	Aalbers et al. (2013)	5	Filieri and Algezauzi (2014)	3
Alin et al. (2011)	8	Unsal and Taylor (2011)	5	Groenewegen (1992)	3
Weber and Weber (2011)	7	Hackney et al. (2008)	5	Poorkavoes et al. (2016)	1
Jolink and Dankbaar (2010)	7	Aalbers et al. (2014)	4	Gilting et al. (2016)	1
Turner and Pennington (2015)	5	Srivastava (2015)	3	Cong et al. (2017)	0
Forzi and Peters (2005)	5	Sosa et al. (2015)	3	Neij et al. (2017)	0
Low and Johnston (2010)	4	Zappa and Lomi (2015)	3	Belso-Martinez et al. (2017)	0
Hustad and Teigland (2005)	4	Lee and Lee (2015)	3	Toigo (2017)	0
Mischen (2015)	3	Shin and Kook (2014)	3	Inkpen and Tsang (2016)	0
Luo et al. (2015)	2	Chan et al. (2008)	3	Poorkavoes et al. (2011)	0
Dong et al. (2011)	2	Kleinbaum and Stuart (2014)	2	Yang and Xu (2010)	0
Bourouni et al. (2014)	1	Sroka et al. (2014)	2	Zhang and Chen (2010)	0
Bagheri et al. (2016)	0	Aalbers and Dolfsma (2015)	1		
Hansen and Pries-Heje (2016)	0	Mollona and Marozzi (2009)	1		
Jansen et al. (2015)	0	Villasalero (2017)	0		
Gopsill et al. (2015)	0	Crispeels et al. (2014)	0		
Meireles et al. (2012)	0	Lamari et al. (2014)	0		
Al-Busaidi (2012)	0	Tang (2007)	0		
Matos et al. (2012)	0	Ma et al. (2005)	0		
Bhattacharjya et al. (2010)	0	Xu et al. (2005)	0		
Zhou et al. (2008)	0				
Grienaldi and Cricelli (2007)	0				
Rodiqi (2007)	0				
Taatila (2007)	0				
Forzi et al. (2004)	0				
Simões and Soares (2004)	0				
Sirkemaa (2002)	0				

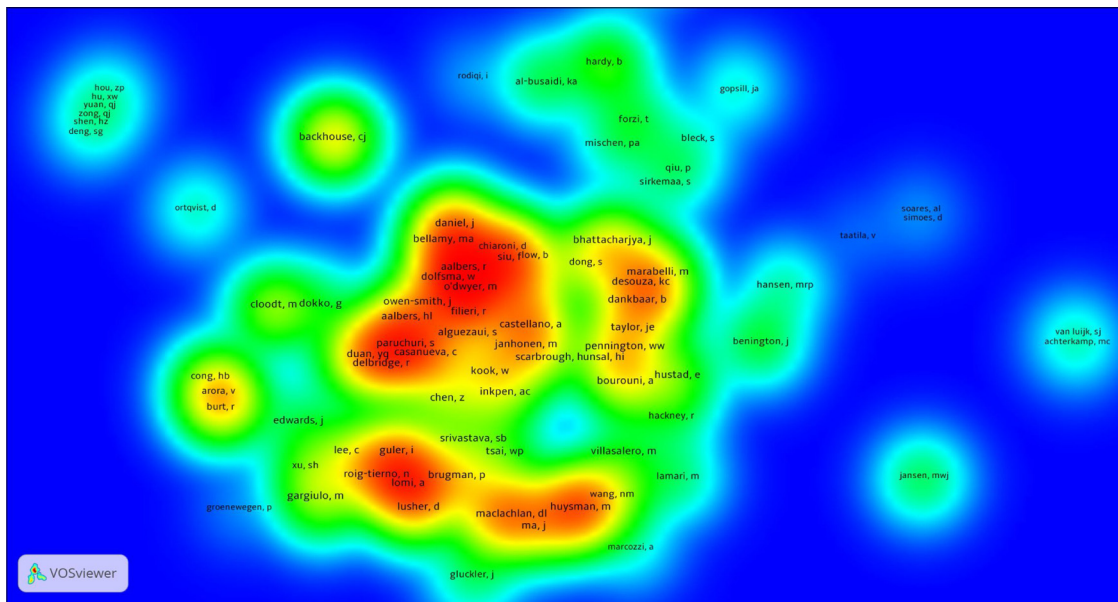


Fig. 4. Authors and density of relationships in the set of studies.

co-citation analyses (Grácio, 2016; Zhao & Strotmann, 2008). Considering that an author's work generally increases over time, bibliographic coupling of authors captures that evolution, in that it considers all the work of the authors analyzed. However, not all the studies of the 232 authors initially identified shared references mutually. That characteristic was identified in the work of 220 authors. As in the bibliographic coupling of documents, no filters were applied concerning the number of articles or citations received by the authors, to allow identification of authors who have begun their research on the subject recently.

Changing the unit of analysis from individual documents to authors allowed construction of a heat map of the volume of scientific production by authors contributing to the subject's development (Fig. 4). The colours on the heat map indicate the intensity of the connection of the authors' scientific production. According to Van Eck and Waltman (2010), the greater the number of items close to a point and the greater the weight of the neighbouring items, the closer the item (author) will be to red.

Observation of the map allows identification of three major groups of authors intensely connected in terms of the sets of references used in their production. In addition, a more detailed analysis of the heat map corroborates identification of 3 clusters in research on knowledge transfer in the organizational network context, as indicated in Table 4.

Foundations of the field

Aiming to aid comprehension of the theoretical foundations of studies on the topic, the network of studies referred to by the 102 articles in the sample was analyzed, by applying the analytical technique of document co-citation (Small, 1973). Here, the focus of analysis moves from the set of articles forming the literature in the field (the 102 articles in the sample) to the set of references quoted by those articles. Examination indicated the presence of 4.406 references, of which 28 had at least 10 citations. This cut-off point is justified as co-citation analysis aims to determine the most important grounding studies on the subject (Small, 1973). The network formed by the main references quoted by the authors addressing the topic of knowledge transfer in inter-organizational networks is presented in Fig. 5.

Analysis of the document co-citation network showed that the articles with the greatest number of citations in the 102 articles in the sample, i.e., the work with greatest impact in the current literature on the subject of knowledge transfer in the network domain, are as follows: Hansen (1999) (29 citations); Cohen and Levinthal (1990) (26 citations); Reagans and McEvily (2003) (22 citations); Tsai (2001) and Grant (1996b) (21 citations each). Two major clusters of studies were identified. The first, shown in Fig. 5 in red, covers studies belonging to an approach related to the theory of networks and social networks. The second group, identified in green, deals principally with work following an approach related to the flow of knowledge in organizations.

Finally, following the recommendations of White and Griffith (1981), the unit of analysis was transferred from documents to authors' collective work, i.e., to studying the frequency with which an author is connected to other authors, without specifying which studies were co-cited by the sample articles. The strategy, based on the assumption that an author's total work represents more appropriately their influence on a field's structure (Grácio, 2016), revealed that 3.127 authors were quoted in the 102 articles in the sample. However, in order to understand clearly which researchers contributed most to the foundations of the field, a cut-off limit of a minimum 20 citations in the set of 102 articles was established. In this way, 26 authors were selected as having their total work related to the subject of this study, as seen in Table 5.

Conclusions and implications

This study identified, described and characterized the origins, evolution and how the intellectual structures of technical knowledge were linked to the knowledge transfer in the context of inter-organizational networks, as well as to the conceptual and methodological foundations of the field literature. To do so, 102 articles were extracted from the Web of Science database. Applying bibliometric techniques and making qualitative analyses of the international studies with greatest impact in the field, it has been noticed that recent years have been marked by increased publications on the subject and an increasing trend of related science. The objectives are considered to have been fulfilled, inasmuch as the first studies associated with these themes were identified and analyzed (Groenewegen, 1992; Van Aken & Weggeman, 2000), as

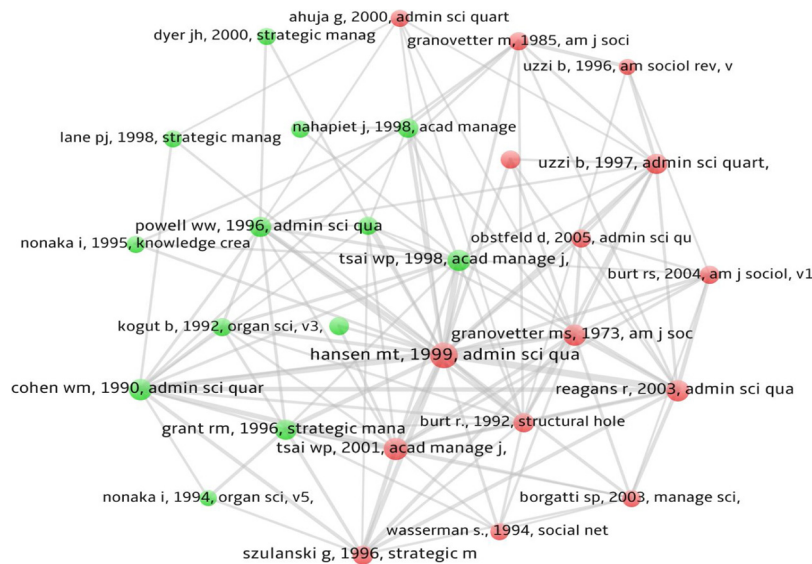


Fig. 5. Network of co-citations and clusters.

Table 5
 Main authors co-cited (total citations in brackets).

Nonaka, I. (56)	Borgatti, S.P. (36)	Argote, L. (27)
Burt, R. S. (51)	Reagans, R. (35)	Ahuja, G. (25)
Hansen, M. T (51)	Tushman, M. L. (31)	Brown, J. S. (25)
Gulati, R. (49)	Kogut, B. (30)	Cross, R. (23)
Tsai, W. P. (48)	Szulanski, G (30)	Ibarra, H. (23)
Granovetter, M. S. (45)	Inkpen, A. C. (28)	March, J. G. (20)
Uzzi, B. (42)	Krackhardt, D.	Podolny, J. M. (20)
Powell, W. W. (38)	Cohen, W. M. (27)	Brass, D. J. (20)
Grant, R. M. (37)	Dyer, J. H. (27)	

well as the principal article that stimulated all scientific production in the following years (Tsai, 2001). In these circumstances, the main components of the intellectual structure characterizing the research already carried out on the subject were identified and discussed. More specifically, the evolution of the studies produced was presented, finding a clear tendency to produce new studies in the following years, indicating to new researchers that this is a promising topic. A survey with more research on the subject is from *Radboud University Nijmegen*. However, the United States is the country with the largest number of publications (e.g., *Organization Science*) identified.

In relation to the field structures, application of the keyword co-occurrence technique allowed us to identify that the themes most approached were innovation and organizational performance. In other words, the literature seeks, in an important way, to understand how knowledge flows and can be appropriated by network participants in order to generate innovation in processes, products and services, as well as improving organizational performance. Several authors (e.g., Efrat, 2014; Kim, 2013) have sought to highlight knowledge flows as drivers for innovation. In addition, the analysis of bibliographic coupling of the analyzed work allowed its classification in three clusters, according to similarity of content and/or methodology. That is, studies are grouped as follows: (i) innovation processes, organizational change and knowledge leakage; (ii) configuration of networks and capacities of knowledge absorption and retention; and (iii) the role of individuals in the networks and forms of network governance.

This study also scrutinized the theoretical foundations of the selected literature, through applying the techniques of analysis of co-citation of documents and authors. Here, two major groups of studies giving origin to the literature on knowledge in the

context of inter-organizational networks stand out. The first group was identified as related to the literature on networks theory and social networks and the second more aligned to studying the flow of knowledge in organizations. The authors contributing most to development of the theme were identified, namely I. Nonaka, R.S. Burt, M.T. Hansen, R. Gulati, W.P. Tsai, M.S. Granovetter and B. Uzzi.

This study also presents some theoretical and practical contributions. The results of this study contribute to advancing knowledge on knowledge transfer in the context of inter-organizational networks. The literature on this topic has originated research with diverse theoretical, quantitative or qualitative approaches. Thus, the theoretical contribution this study seeks to provide is an organized and classified view of how the theme of knowledge transfer in the context of inter-organizational networks has been explored in the literature. This study contributes, therefore, to a better visualization of the types of approaches and of attempts to measure this phenomenon inside and outside the organizations, and how it has been applied strategically in organizations.

From a practical viewpoint, the results seek to broaden the knowledge about the phenomenon studied, highlighting new gaps that provide an advance in the theme, allowing researchers, policy-makers and practitioners to opt for more productive and successful paths in their organizations, a practical gain so to speak, resulting in better identification of the opportunities arising within the environment.

Despite these contributions, it is necessary to recognize the existence of some limitations, starting with the limited presentation of theoretical aspects of knowledge transfer in the context of inter-organizational networks, which can be explained by the emphasis given to quantitative aspects of the literature on the subject, a characteristic of bibliometric studies. In addition, the study does not make direct contributions to commercial practice, although this may occur indirectly by encouraging and directing future research. It is also important to focus the analyses on the set of selected works from the use of specific keywords, as well as the use of only one database (*Web of Science – SSCI*). Thus, one recommendation is to expand the survey using more databases to collect articles related to the subject, even considering that this base used (SSCI) is recognized as a reference for academia, as this would make the study more robust, thus eliminating that limitation.

Furthermore, it is recommended that future researchers explore various research possibilities. For example, it would be particularly interesting to examine more recent and less cited publications that were less relevant to the analyses carried out, which could lead to identifying alternative theoretical clusters. The application of alternative methodologies (e.g., Marchiori & Mendes, 2018) would also complement the results reported here. For example, future work could generate networks of keyword co-occurrence, in order to identify the binding strength of the identified sub-themes and explore the promising possibilities of associating relevant subtopics or of different grouping solutions in the literature. That is, these and other alternative methodological approaches can enrich this research, especially considering the increasing rate of publications in the field, the complexity of review processes and the evolution of methodological trends.

Finally, considering that more research is under way and further work will provide deeper analysis of the subject, we hope that the results presented here can be sources of inspiration for further studies involving the profitable relationship between knowledge transfer and networks of organizations, as it provides future researchers with useful information to design, conduct and disseminate their research. Thus, we hope that researchers, policy-makers and practitioners in the areas of organizational networks and knowledge transfer can look beyond their immediate interests and boost the momentum and growth of this promising area of research, as well as benefiting from this study which can provide powerful drivers for the understanding, management and performance of modern organizations.

Acknowledgements

The authors thank the anonymous reviewers for their very helpful comments that contributed to the development of this paper. The authors gratefully acknowledge financial support from National Funds of the FCT – Portuguese Foundation for Science and Technology within the project «UID/ECO/04007/2019».

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