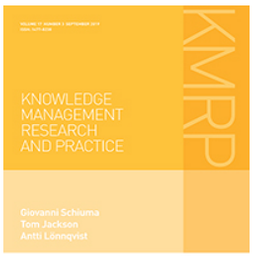

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ORIGINAL ARTICLE

Network level knowledge sharing: Leveraging Riege's model of knowledge barriers

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ABSTRACT

This paper identifies the key knowledge barriers typical for inter-organisational relationships and networks. Riege's well-known model of knowledge barriers classifies barriers as individual, organisational and technological level hindrances, but leaves out the network level in particular. Based on a review of the top five knowledge management journals, this paper leverages Riege's model to apply it at the network level. The added network-level barriers are geographical distance, cognitive proximity, strength of relationship and lack of intermediator. The literature review also revealed knowledge-specific barriers, i.e., ambiguity, complexity, stickiness, tacitness and knowledge protection, as the critical knowledge barriers in inter-organisational co-operations. By revealing the typical knowledge barriers at the network level, this paper develops knowledge management practices for networks. Managers responsible for network development and management in general need such practices, as knowledge sharing has been recognised as a key source of competitiveness and simultaneously one of the main challenges faced in networks.

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Knowledge sharing; knowledge barriers; knowledge management; networks; inter-organisational

1. Introduction

The statement "no business is an island", previously presented in the seminal work of Håkansson and Snehota (1989) on industrial networks, describes the important role of inter-organisational relationships and networks in complex business environments. It is no surprise that networks have been widely discussed for decades, particularly in marketing and management literature (Easterby-Smith, Lyles, & Tsang, 2008; Easton, 1992; Gulati, Nohria, & Zaheer, 2000; Möller, Rajala, & Svahn, 2005). For many companies and organisations, the ability to act in networks and build inter-organisational relationships is a matter of survival. However, major challenges exist in the network context (Tsai, 2001). In the network literature, a lack of appropriate knowledge management practices for networks has consistently been found to be the most critical failure factor (Ke & Wei, 2007; Trkman & Desouza, 2012), leading research to cover the risks associated with managing knowledge in networks (Marabelli & Newell, 2012; Trkman & Desouza, 2012). Nevertheless, overall past research on knowledge management at inter-organisational network level is often insufficient and includes deficiencies (Valkokari & Helander, 2007). This is the case especially when network-level knowledge sharing and knowledge barriers are the focus. Only few exceptions can be found, like the work of Solli-Sæther, Karlsen, and van Oorschot (2015), which studied the knowledge barriers in project networks, and Loebbecke, van Fenema, and Powell (2016), which presented a four-part configuration for managing inter-organisational knowledge sharing between network members.

The lack of studies specifically addressing knowledge sharing at the inter-organisational network level is surprising, as there are even networks that have been established solely for the purpose of sharing knowledge. Verburg and Andriessen (2011), Nielsen (2002), and Ilvonen and Vuori (2013) define these as knowledge networks. According to Magnusson and Nilsson (2003), the strategic reason for creating a network around knowledge sharing can be business-oriented or learning-oriented. Parties entering a network with a business-orientation aim intend to obtain maximum monetary advantage of the available knowledge, whereas the motivation of learning-oriented parties is to share knowledge in order to create new knowledge and competences (Magnusson & Nilsson, 2003). These kinds of knowledge networks can be closed or open (Collison, 1999), can vary in geographical dispersion (Kimble, Hildreth, & Wright, 2001) and size (Brown & Duguid, 2000), and interact face-to-face or via ICT (Kimble et al., 2001). Furthermore, these knowledge networks can also be either intra-organisational or inter-organisational (Brown &

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Duguid, 1991; Collison, 1999). In fact, most of the studies on knowledge networks focus on the intra-organisational level, again leaving the inter-organisational network level out of the scope.

Whether intra-organisational or inter-organisational, knowledge networks usually call for coordination to some extent in order to flourish (Myllärniemi et al., 2013). This is emphasised especially in co-opetitive networks if one of the member companies acts as the coordinator instead of an impartial intermediator (c.f. Mowery, Oxley, & Silverman, 1996; Salvetat, Géraudel, & d'Armagnac, 2013). Co-opetitive networks are an extreme example of inter-organisational networks, which especially place the emphasis on knowledge sharing and on coordination. Cricelli and Grimaldi (2010) have addressed this kind of coordination aspect in knowledge networks. They (Cricelli and Grimaldi, 2010) suggest that there are different types of networks depending on the emphasis of the two dimensions, varying from a highly coordinated "knowledge chain" that aims to apply knowledge in production, to autonomous "learning networks" that focus on sharing tacit knowledge and experiences to facilitate learning (Cricelli & Grimaldi, 2010). Whatever the extent of coordination, it can be argued that managing knowledge sharing in an inter-organisational network by developing capabilities and routines within the network enhances the premises for success (Loebbecke et al., 2016).

Nevertheless, managing knowledge sharing in networks is challenging due for example to the multifaceted nature of knowledge, the balancing of organisations between the risks and benefit viewpoints of knowledge sharing, IT issues, and motivating individuals within the network to actually share their knowledge (e.g., Easterby-Smith et al., 2008; Marabelli & Newell, 2012; Trkman & Desouza, 2012). Despite the acknowledged challenges, knowledge sharing should be coordinated and managed at least to some extent. It is important to understand how to manage knowledge networks and improve their operations, as well as to reduce the restraints of knowledge sharing. Based on a thorough literature review of the five top knowledge management journals, the purpose of this paper is to identify key knowledge barriers that are typical for inter-organisational networks.

Thus, in order to identify the state-of-the-art, i.e., the "collective conception" of network level knowledge barriers as well as to identify possible gaps in the prevailing classification of knowledge sharing barriers the research questions of the paper are:

- RQ1: How have the top five knowledge management journals discussed network-level knowledge barriers during the last thirteen years?
- RQ2: How does Riege's (2005) model fit within the network-level context in terms of knowledge barriers?

The paper begins by justifying the need to address knowledge barriers as well as by utilizing Riege's (2005) groundbreaking and widely referred to model as a framework for viewing these barriers on network level. Next, a literature review explains how the top five journals in the knowledge management field have discussed network-level knowledge sharing and barriers during the last thirteen years (2005–2018). The results section presents network-level knowledge barriers based on a literature review. The key literature review findings are discussed in comparison to earlier research on the role of knowledge management in the network context in marketing and management studies. We suggest a revision of Riege's (2005) model with additional knowledge barriers. Finally, some emerging issues and ideas for future research are discussed in order to open up the way for new studies to advance the understanding of network-level knowledge barriers.

2. Theoretical background: knowledge sharing and knowledge barriers

Knowledge sharing is a focal element of knowledge management (cf. Alavi & Leidner, 2001; Earl, 2001; Nahapiet & Ghoshal, 1998; Nonaka, 1994; Sveiby, 1997). Knowledge sharing is making acquired knowledge available to others (Ipe, 2003; Ryu, Ho, & Han, 2003). It is a voluntary, conscious act between and among individuals as well as within and among organisations, resulting in joint ownership of knowledge between sender and receiver (Bock & Kim, 2002; Davenport, 1997; Ipe, 2003; King, 2006; Lee, 2001; Lin & Lee, 2004). The terms "knowledge sharing" and "knowledge transfer" are often used interchangeably to describe this activity, and there are no unified definitions of the distinction between them (cf. King, 2006; Paulin & Suneson, 2012; Schwartz, 2007). According to King (2006), knowledge transfer is focused and has a clear objective and recipient, whereas knowledge sharing can happen unintentionally in multiple directions and does not necessarily have any specific objective (King, 2006). Schwartz (2007) proposes that knowledge sharing and knowledge transfer differ from each other in the viewpoint: knowledge sharing focuses on the individual's view ("people share knowledge"), whereas knowledge transfer takes the organisational perspective ("organisations transfer knowledge"). A common distinction between knowledge sharing and knowledge transfer is whether the knowledge is applied or not within the process: knowledge sharing is merely imparting knowledge to others, whereas knowledge transfer

encompasses the use of the shared knowledge (Abou-Zeid, 2005; Argote, 1999; Bircham, 2003; Darr & Kurtzberg, 2000; King, 2006). This paper focuses on what impedes individuals and organisations from sharing their knowledge within networks, but it does not take into account whether the shared knowledge is used or not. Therefore, the term "knowledge sharing" is used throughout the paper.

Paulin and Suneson (2012, p. 82) describe a knowledge barrier as follows: "where there is a knowledge barrier, new information cannot be understood or interpreted". A knowledge barrier can be an explicit barrier or the absence of a critical success factor in knowledge sharing (Schwartz, 2007). This implies that barriers and motivational factors are two sides of the same coin, and turning the coin around changes the circumstances for knowledge sharing. Wang and Noe (2010, p. 121) take the same stance by itemizing "reasons for sharing or not sharing knowledge", i.e., factors that can either boost or hinder knowledge sharing. For example, the perceived value of the knowledge impacts the motivation to share it (Barachini, 2009). If knowledge is considered as a source of power and superiority, understanding the value of knowledge can become a knowledge barrier (Wang & Noe, 2010). The emotional ownership of highly valuable knowledge is strong (Jones & Jordan, 1998), and consequently, valuable and important knowledge is often hoarded and covetously protected (Davenport, 1997).

Organisational culture moulds the understanding of which knowledge is valuable (De Long & Fahey, 2000) and is generally acknowledged as having a significant effect on knowledge sharing (see e.g., Al-Adaileh & Al-Atawi, 2011; Hannon, 1997; Ipe, 2003). For example, if organisational culture links knowledge sharing to politics or impression management motives it is likely to diminish knowledge sharing (Wang & Noe, 2010). People also tend to ponder the risks or social consequences of knowledge sharing. Worries about knowledge proving to be inaccurate, unreliable, unvalued or receiving criticism from others hinders knowledge-sharing activities (Ardichvili, Page, & Wentling, 2003; Wang & Noe, 2010). Another restraint regarding knowledge sharing entails not knowing which knowledge to share or whether it is in anyone's interest to receive the knowledge in the first place (Ardichvili et al., 2003; Hannon, 1997). On the other hand, highly knowledgeable individuals, whose knowledge would be worth sharing, may not be eager to spend time sharing knowledge as they do not anticipate high enough reciprocity or personal gain from others (Vuori & Okkonen, 2012; Wang & Noe, 2010). Knowledge barriers are also related to the opportunities that exist for sharing knowledge. These are provided, or prevented, by formal channels, such as technological solutions, and informal channels, including personal relationships and social networks (Ipe, 2003; Nahapiet & Ghoshal, 1998).

In his groundbreaking, widely referred to review article on knowledge barriers, Riege (2005) divides knowledge barriers into individual, organisational and technological categories (Figure 1). The latter can arguably originate from the individual level, as ultimately individuals are always the actors performing knowledge sharing, regardless of the platform.

While Riege's (2005) categorisation seems extensive, it fails to include a significant category, or context, if you will, in the model – barriers

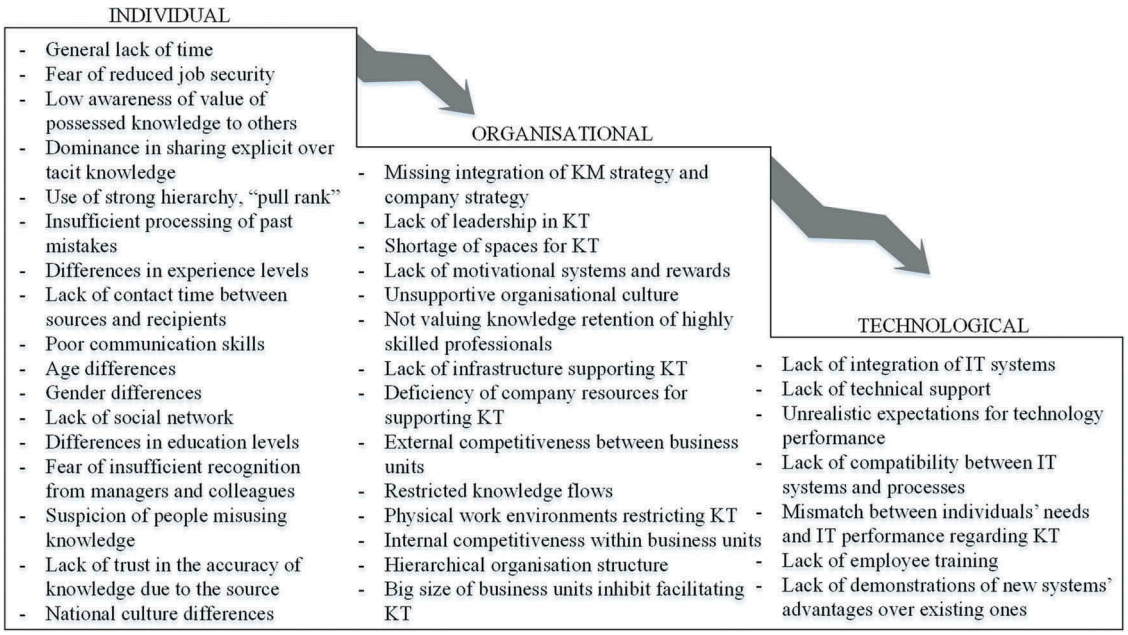

Figure 1. Categorisation of knowledge barriers (Riege, 2005).

regarding inter-organisational knowledge sharing – even though these barriers are clearly present, both in everyday business as well as being reported in research articles. For example, in the 1990s, Szulanski (1996), Lane and Lubatkin (1998), Kostova (1999) and Simonin (1999) acknowledged that context-specific factors, such as prior experience, cultural distance and organisational distance influence the effectiveness of inter-organisational knowledge sharing. More recently, cultural-specific factors have also been raised as an issue (see e.g., Abou-Zeid, 2005; Solli-Sæther et al., 2015). As Riege's (2005) model has compiled a substantial and noteworthy set of knowledge barriers from relevant literature, we aim to add to this prominent research by focusing on knowledge barriers in a network context.

3. Literature review on network-level knowledge barriers

With the exception of a few studies (Loebbecke et al., 2016; Solli-Sæther et al., 2015), past research on knowledge management was found to be insufficient and to include shortcomings, especially in terms of network-level knowledge sharing or knowledge barriers. To confirm these observations and to ensure that all relevant research in the field of knowledge management was taken into consideration, a systematic review was used (Tranfield, Denyer, & Palminder, 2003) to capture the latest information. As said (Kitchenham, 2004), a systematic literature review is "a means of evaluating and interpreting all available research relevant to a particular research question or topic area or phenomenon of interest." A systematic literature review is a way to offer new insights and identifying possible gaps or need for additional studies. As stated in Kitchenham (2004), a systematic literature review is "a means of evaluating and interpreting all available research relevant to a particular research question or topic area or phenomenon of interest." A systematic literature review is a way to offer new insights and identify possible gaps or the need for additional studies. With a systematic approach, the role of researchers is made more explicit, thus reducing the influence of opinions and intuition. As knowledge sharing and its importance have been recognised in "general" network-level discussions (e.g., Ke & Wei, 2007; Trkman & Desouza, 2012), we focused especially on the area of knowledge management through the five most highly ranked academic journals in the field of knowledge management (Serenko & Bontis, 2017): Journal of Knowledge Management, Journal of Intellectual Capital, The Learning Organization, Knowledge Management Research & Practice and Knowledge and Process Management.

These top five KM/IC academic journals follow a rigorous peer-review process, focus on KM and IC and analyse these issues from managerial, business, information systems, policy or economics perspective. The ranking of these journals is based on a combination of results from a survey of almost 500 active KM/IC researchers and journal citation impact indices (Serenko & Bontis, 2017). This kind of ranking list signifies the very existence of an academic discipline: it is a "mouthpiece" for collective conception of KM as it is. We chose to include only the top five journals into the review since they differ from the rest of the ranked journals by being ranked A+ or A level and having held their top five position also in all previous ranking studies in 2008 (Serenko & Bontis, 2009) and 2012 (Serenko & Bontis, 2013), and can therefore be seen as established their position as the most distinguished and focal journals in the field of KM.

The literature review is based on these five selected journals with search themes such as knowledge sharing, knowledge transfer, knowledge exchange, knowledge supply AND network (inter-organisational relationship) AND barriers, hindrances or other similar terms. For the purposes of this study, only scholarly articles published in English between 1/2005 and 4/2018 were included. The time span of over thirteen years adequately showed the various discussions that have taken place in the selected journals.

Based on this selection, a systematic search was conducted using the following criteria: either one or some of the terms had to be mentioned in the abstract. If the term did not occur in the abstract, then it was not central enough in the article. However, the search also relied on the researchers' intelligence concerning the contents of the article even if the exact same term was not found. The search resulted in a total of 2490 articles. All abstracts were manually screened in order to verify if the articles indeed discussed the themes of the research. Based on this method, a total of 35 articles met the search criteria and were selected as a basis for the final analysis. A quantitative summary of the yield of the review is presented in Table 1.

Researcher triangulation was used both during the article search as well as when the articles were analysed, as all three researchers participated in the process. All of the participating researchers viewed and discussed Riege's (2005) model in light of the articles found. Based on the systematic literature review, some knowledge barriers mentioned in network-level studies were also found that did not fit into any category of Riege's original model (2005). For these identified barriers, two additional barrier groups were added to the original model.

Table 1. Yield of the systematic literature review.

Journal	Numbers (11/2005–4/2018)	Articles (11/2005–41/2018)	Articles meeting the search criteria
Journal of Knowledge Management (JKM)	81	809	16
Journal of Intellectual Capital (JIC)	54	478	3
The Learning Oranization (LO)	80	412	4
Knowledge Management Research & Practice (KMRP)	52	487	9
Knowledge and Process Management (KPM)	53	304	3
Total	**320**	**2490**	35

4. Results

As a result of the literature review, Table 2 presents knowledge barriers in a network context. All three levels in Riege's (2005) classification can be found within the network context. However, the network context elicits specific factors influencing the effectiveness of inter-organisational knowledge sharing, making them potential knowledge barriers. These categories are network-specific and knowledge-specific. The table includes the knowledge barriers included in Riege's (2005) model that were in the reviewed articles (italics) completed with additional knowledge barriers found in the articles (bold). The knowledge barriers of Riege's (2005) model that were not present in the articles have been omitted from the table. Riege's (2005) organisational knowledge barriers could also be seen as network-specific knowledge barriers, since a network is one kind of organisation.

4.1. Individual-level knowledge barriers

Differences in experience levels can also become a knowledge barrier in the network context. Prior experience influences the effectiveness of inter-organisational knowledge sharing (Abou-Zeid, 2005): the more accustomed an individual is to collaborating over organisational borders, the more

Table 2. Knowledge barriers in the network context.

Individual	Organizational	Technological	Network-specific	Knowledge-specific
Differences in experience levels (Korbi & Chouki, 2017; Santos et al., 2012; Abou-Zeid, 2005)	*Missing integration of KM strategy and company strategy* (Tiwari, 2015; Mariotti, 2007)	*Lack of compatibility between IT systems and processes* (Korbi & Chouki, 2017; Corallo et al., 2012)	Geographical distance (Korbi & Chouki, 2017; Corallo et al., 2012; Bocquet & Mothe, 2010)	Complexity (Abou-Zeid, 2004; Hislop, 2005)
Poor communication skills (Santos et al., 2012)	*Lack of leadership in knowledge sharing* (Tiwari, 2015)	*Mismatch between individuals' needs and IT performance regarding knowledge sharing* (Santos et al., 2012; Corallo et al., 2012)	Cognitive proximity (similarity of the network members), endogamies & exogamies (Khamseh & Jolly, 2014)	Stickiness (Jonsson & Kalling, 2007; Schwartz, 2007)
Lack of social network (Santos et al., 2012)	*Shortage of space for knowledge sharing* (Mariotti, 2007)	*Lack of employee training* (Santos et al., 2012, Corallo et al., 2012)	Strength of relationship, trust (Solitander & Tidström, 2010; Hislop, 2005)	Tacitness (Abou-Zeid, 2004; Hislop, 2005)
General lack of time (Santos et al., 2012)	*Unsupportive organizational culture* (Tiwari, 2015; Mariotti, 2007; Abou-Zeid, 2004)		Lack of intermediator (Bocquet & Mothe, 2010)	Ambiguity (Khamseh & Jolly, 2014)
Low awareness of value of possessed knowledge to others (Tiwari, 2015)	*Lack of infrastructure supporting knowledge sharing* (Santos et al., 2012)			Knowledge protection (Solitander & Tidström, 2010; Khamseh & Jolly, 2014; Corallo et al., 2012; Salvetat et al., 2013)
Dominance in sharing explicit over tacit knowledge (Santos et al., 2012)	*Restricted knowledge flows* (Tiwari, 2015)			
Suspicion of people misusing knowledge (Santos et al., 2012; Tiwari, 2015; Solitander & Tidström, 2010)	*Internal competitiveness within business units* (Solitander & Tidström, 2010; Corallo et al., 2012)			
Lack of trust in the accuracy of knowledge due to the source (Tiwari, 2015; Solitander & Tidström, 2010)				

effective he/she is at transferring knowledge within the network and reaping the benefits. Another hindrance is the use of different technological terminology (Santos, Soares, & Carvalho, 2012). If the level of expertise varies considerably, it may cause difficulties in understanding. The latter could also be classified under poor communication skills and other communication barriers, which include the lack of a common technological language, conflicting personal backgrounds, different time zones, poor understanding of national cultures and incompatible technological contexts (Korbi & Chouki, 2017; Santos et al., 2012). As knowledge sharing in networks occurs between individuals, the individual's social networks play a role in knowledge-sharing success; thus lack of a social network is a knowledge barrier.

A general lack of time is another knowledge barrier at the individual level that is present in the network context. This barrier is often shown as the absence of a proper balance between knowledge codification and time (Santos et al., 2012). Information overload on diverse information systems, excessive use of email, and exchanging common information between parties (Santos et al., 2012) is also time-consuming and creates knowledge barriers within the network. Low awareness of the value of possessed knowledge to others can appear if the network members lack a long-term vision in regard to engagement with other actors in the network (Tiwari, 2015). If the objectives of knowledge sharing in the network are not clear to some, they cannot understand the knowledge needs of other participants, and therefore knowledge sharing remains ineffective. If the knowledge sharing in the network stresses explicit forms of knowledge, the dominance of sharing explicit over tacit knowledge may hinder knowledge sharing, as some knowledge cannot easily be transferred in explicit form (Santos et al., 2012).

A common restraint of knowledge sharing is suspicion of people misusing the knowledge. Interdependence of knowledge and skills may be challenging, as organisations that deal with sensitive information or knowledge tend to work in a protective manner, restricting the exchange of knowledge and skills (Santos et al., 2012). In situations where knowledge sharing takes place between organisations that are simultaneously each other's competitors (i.e., co-opetition), knowledge sharing is not always beneficial to the originator. Suspicions of, for example, partners copying products can change one's willingness to provide knowledge to other participants (Solitander & Tidström, 2010). In addition, lack of trust in the accuracy of knowledge due to the source is a knowledge barrier, especially in co-opetitive networks where suspicions of partners' hidden agendas (e.g., providing misinformation) changes the trustworthiness experienced of knowledge gained through the network (Solitander & Tidström, 2010). The articles revealed that knowledge was not absorbed if trust had not yet been built between network members. Trust plays an important role in improving the effectiveness of knowledge transfer and acquisition (Tiwari, 2015). Correspondingly, participants are motivated to collaborate in future networks because of existing trust and satisfaction from past engagement (Tiwari, 2015).

4.2. Organisational knowledge barriers

Lack of the integration of knowledge management strategy and company strategy appears to be a knowledge barrier in the network context as well. Without a joint objective and strategy for the network, knowledge sharing may be ineffective. Therefore, when establishing networks, managers should be more aware of different types of knowledge and the fact that the success of collaborative ventures can be determined by how knowledge is identified, coordinated and used (Tiwari, 2015). In addition, the culture of working together should be promoted, as it is a focal factor in generating knowledge sharing (Mariotti, 2007). Strategy building and promoting collaboration calls for leadership. Professional knowledge resides with individual actors, but it has to be coordinated and integrated seamlessly (Tiwari, 2015). Thus a lack of leadership in knowledge sharing is a hindrance for knowledge sharing. If there is a shortage of spaces for knowledge sharing, knowledge may not be transferred from source to recipient, as knowledge sharing is generated by co-location, shared education and training and use of resident employees (Mariotti, 2007). An unsupportive organisational culture, as well as different organisational cultures in the source and recipient firms, affects the success of inter-organisational knowledge sharing (Abou-Zeid, 2005). Correspondingly, social capital and close relationships create the prerequisites for organisational interaction and facilitate the generation and transfer of knowledge (Mariotti, 2007). A lack of infrastructure that supports knowledge sharing is also a knowledge barrier. Misunderstandings are more common when communication occurs through technological means in written form, e.g., email. Therefore, it is advisable to adopt communication tools such as video-conferences where persons can be seen (Santos et al., 2012). In addition, in many cases, networks do not have a formal structure that governs the operations on a network level. This also applies to network-level knowledge acquisition and integration in the form of restricted knowledge flows: specific knowledge is distributed and within the domain of individuals. However, networks are extremely dependent on acquiring this scattered knowledge (Tiwari, 2015).

In the network context, internal competitiveness within business units translates into competition between network participants. This kind of co-opetitive relationship sets challenges for knowledge sharing (Solitander & Tidström, 2010) in terms of knowledge protection, knowledge trustworthiness and general lack of trust between the participants. The importance of knowledge protection is emphasised in networks with a view to new product development (Corallo, Lazoi, & Secundo, 2012).

4.3. Technological knowledge barriers

Technological knowledge barriers are all situational. In other words, they are significant only if knowledge sharing is mainly or solely based on using technological aids (e.g., knowledge management systems or social media platforms) or if the network is a highly integrated supply chain alliance using joint IT systems. In these situations, lack of compatibility between IT systems and processes may become a key knowledge barrier if the network members have different ICT systems that do not interoperate (Corallo et al., 2012; Korbi & Chouki, 2017). In addition, a mismatch between individuals' needs and IT performance regarding knowledge sharing may generate a knowledge barrier if the tools available to share knowledge are time-consuming and not user-friendly (Santos et al., 2012). In this situation, the knowledge sharing systems are mainly process-oriented and do not support "fuzzy" content (Santos et al., 2012), or people have difficulties retrieving useful information (i.e., finding the right people or documents, databases or other knowledge sources) (Corallo et al., 2012). The issue of finding the right people results from a lack of employee training, as people do not have the skills to search for information (Corallo et al., 2012) and use divergent solutions and tools due to the absence of standards or training (Santos et al., 2012).

4.4. Network-specific knowledge barriers

We would argue that the "new" network-specific category includes the same knowledge barriers that were identified as occurring in the organisational category, since a network is seen as a combination of interoperating organisations in this context. However, the literature review reveals the following additional knowledge barriers that are specific to networks. Often the networks are on a global level, leading to geographical distance between the network parties. Geographical distance, according to Korbi and Chouki (2017), Corallo et al. (2012) and Bocquet and Mothe (2010), is one of the barriers that hinders knowledge sharing on a network level. Companies with cognitive proximity risk not being able to absorb and use new knowledge gained from the network (Khamseh & Jolly, 2014). Also, the knowledge barriers within networks often depend on the trust and strength of relationships (Hislop, 2005; Solitander & Tidström, 2010). The more the members interact and experience reciprocity and appreciate the value of knowledge sharing, the more they trust the network, which consequently decreases knowledge barriers. Sometimes a lack of an intermediator decreases knowledge sharing between network members (Bocquet & Mothe, 2010), especially in the case of geographically or culturally distant network members.

5. Knowledge-specific features of knowledge barriers

The literature review revealed that the knowledge barriers included in Riege's (2005) classification lack an essential group of barriers related to the knowledge itself. These knowledge-specific barriers refer to the built-in characteristics of knowledge. Complexity can originate from cultural (e.g., occupational, national, organisational, societal culture) differences leading to diverse interpretations of knowledge (Abou-Zeid, 2005; Korbi & Chouki, 2017). Furthermore, the larger the network, or the weaker the ties between network members, the more of a risk complexity becomes for sharing knowledge (Hislop, 2005). The same logic also underlies the sharing of tacit knowledge (Hislop, 2005). The tacitness of knowledge – knowledge being embodied in a person, organisation, activity or situation – makes it hard to extract or to explain explicitly (Abou-Zeid, 2005; Hislop, 2005). Stickiness of knowledge affects the ease of sharing knowledge as well its integration (Schwartz, 2007). Sticky knowledge also creates barriers by being expensive to acquire, share and apply in a new location (Jonsson & Kalling, 2007). All of the aforementioned features of knowledge – complexity, tacitness and stickiness – underline its ambiguous nature. The ambiguity of knowledge varies depending on the network and has a less negative effect on knowledge sharing when the network is comprised of members with similar resources (Khamseh & Jolly, 2014). In addition, knowledge protection may negatively affect knowledge sharing when network members have to be aware of not sharing critical knowledge with others (Corallo et al., 2012; Khamseh & Jolly, 2014; Salvetat et al., 2013; Solitander & Tidström, 2010). This can lead to an overprotective attitude that hinders the sharing of non-critical information.

6. Conclusions

This study extends the previous research on knowledge management, as past research on knowledge management was insufficient and included deficiencies regarding network-level knowledge sharing and knowledge barriers. To our knowledge, this paper is

the first systematic literature review on knowledge barriers at the network level that has been carried out from top knowledge management journals. Our study uses Riege's (2005) model of knowledge barriers as a framework, as well as 35 articles published in the top five knowledge management journals throughout the past thirteen years. This topic is of interest because companies collaborate within networks and ecosystems, and sharing knowledge is more or less inevitable. This study provides some answers to how to share information in the most efficient way at network level.

We found that all three levels – individual, organisational and technological – in Riege's (2005) model can be found within the network context, but these categories do not include all of the single barriers listed in the original model. Individual categories were stressed when the focus was on networks. This is quite natural, as individuals are the people who share knowledge even when operating in the network context. Likewise, the organisational category was strongly exposed to the network-level knowledge barriers. Issues related to management and leadership as well as a shortage of spaces and infrastructure to support organisational knowledge sharing were pinpointed in the articles dealing with network levels. This is also quite understandable, as networks are organisations, and issues of management and leadership are key in network success. Knowledge barriers related to technology were found to be situational. This means that a mismatch between IT systems and knowledge sharing processes is significant if knowledge sharing is mostly based on using technological aids. However, few technology issues were considered to be challenges causing knowledge barriers on network level. One potential explanation for this is that the systematic review was carried out from top knowledge management journals instead of top journals in the field of information management and information systems. On the other hand, we found in practice that when operating with networked organisations, usually the most important barrier is related in some way to human actions, not to technology.

Based on our literature reviews and Riege's (2005) model, we found that the network context seems to elicit specific factors that influence the effectiveness of inter-organisational knowledge sharing, thus making them potential knowledge barriers. These factors were categorised as network-specific and knowledge-specific. Among the newly found network-specific factors was the network's cognitive proximity (Khamseh & Jolly, 2014), geographical distance between the network members (Bocquet & Mothe, 2010; Corallo et al., 2012, Korbi & Chouki, 2017), lack of intermediator (Bocquet & Mothe, 2010), and trust and strength of relationships (Hislop, 2005; Solitander & Tidström, 2010). In order to further understand these knowledge barriers and their effect on a network's knowledge sharing, we broadened our scope of research to sources outside the literature review. According to Vale and Caldeira (2007), firms with similar bodies of knowledge (cognitive proximity) may not to be able to absorb and use new knowledge from the network so easily. According to Wuyts, Colombo, Dutta, and Nooteboom (2005) and Nooteboom (2006), cognitive proximity makes it easier to acquire a partner's knowledge, but the value of the knowledge may not be high, as it may already be familiar to the receiver. Even if a great cognitive distance creates difficulties in combining partners' capabilities, knowledge is beneficial.

While very close cognitive distance enables the exploitation of transferred knowledge, it also creates a risk of knowledge spillovers in networks, as network members' markets or technologies may be similar, and the leaking of knowledge may cause competitive risks (Grant & Baden-Fuller, 2004; Trkman & Desouza, 2012). Knowledge protection is emphasised especially in co-opetitive networks (Ilvonen & Vuori, 2013; Solitander & Tidström, 2010) or in supply chain networks where some of the members may be suppliers for the other members' competitors (Solli-Sæther et al., 2015). Quintas, Lefere and Jones (1997) referred to this situation as the boundary paradox, which occurs when a company faces the risk of exposing their own vital knowledge while seeking external knowledge. While an intermediator can promote trust and allocate network resources optimally (Myllärniemi et al., 2013), the lack of intermediator can become a focal knowledge barrier in the network context (Bocquet & Mothe, 2010).

In this search of a broader discussion of network-specific barriers, we found more justification for a newly identified barrier also, namely the network's geographical proximity (Lemarié, Mangematin, & Torre, 2001; Narasimhan & Nair, 2005; Vale & Caldeira, 2007). Geographical distance plays a role in the motivation for joining a network: a more distant firm's motive is to gain access to knowledge (Vale & Caldeira, 2007), whereas close distance facilitates frequent interaction, which consequently enables trust building and diminishes the risk of cultural differences, thus eliminating some knowledge barriers (Trkman & Desouza, 2012). However, geographical proximity can also become a central knowledge barrier if the network relationship is co-opetitive (Solitander & Tidström, 2010; Trkman & Desouza, 2012).

Additionally, we found that Riege's (2005) classification could be completed by the category of knowledge-specific barriers. In addition to these barriers revealed by the study (complexity, stickiness, tacitness, and ambiguity of knowledge), we suggest that the theme and nature of knowledge can also pose challenges for knowledge sharing.

For example, knowledge regarding competitive issues, i.e., competitive knowledge (Vuori, 2011), may be fragmented pieces of knowledge, weak signals or personal interpretations of rumours and their implications and reliability. This kind of uncertainty and incompleteness of knowledge may create a barrier for individuals to share knowledge (Vuori, 2011). Another feature of knowledge that may be a barrier is its stickiness, i.e., knowledge being inert, difficult to imitate and hard to isolate from its source (Liu & Liu, 2008; Szulanski, 2003; Turban, McLean, Wetherbe, Bolloju, & Davison, 2001; von Hippel, 1994). Similarly, the concept of situatedness refers to the fact that knowledge cannot be disembodied from the situations where people use it, which in turn can impede the sharing or using of knowledge in a different context (e.g., Marabelli & Newell, 2012).

We argue that these two new categories, network-specific and knowledge-specific knowledge barriers, need to be taken into account because operations on an inter-organisational network level are more complex than on an intra-organisational level, and thus, special attention to knowledge sharing is required. However, we also suggest that the addition of a knowledge-specific barrier category to the model focuses more attention on the quality of the shared knowledge. To summarise, in order to develop appropriate knowledge management practices for networks, it is important to be able to identify the typical barriers in network-level knowledge sharing.

The new and completed categorisation based on a systematic literature review contributes to the field of knowledge sharing on network level by identifying the key knowledge barriers typical for inter-organisational relationships and networks. By revealing these typical knowledge barriers at a network level, this paper contributes to the development of knowledge management practices for networks. Management, and especially managers responsible for network development, need these kinds of practices, as knowledge sharing has been recognised one of the main challenges in networks. Marabelli and Newell (2012) note that knowledge-sharing research tends to stress the collective level over the individual level. This tendency may complicate the development of suitable management practices, as it should be remembered that the decision to share or not to share knowledge is ultimately up to the individual acting in the network. It can also be argued that in Riege's (2005) classification, the organisational and technological knowledge barriers originate from the individual level, as ultimately individuals are always the actors who perform knowledge sharing. Therefore, attention should be paid to the factors that hinder knowledge sharing between network members.

This paper also has its limitations. The paper examines only one model of knowledge barriers. In addition, the study encompasses thirteen years of relevant research articles, thus it is limited to more recent research. Furthermore, the review was restricted only to the top knowledge management journals, leaving out e.g., the more general management-focused journals from a thorough review.

In considering the implications for future research, one potential direction would be to widen the review, including not only top knowledge management journals but also top general management journals and/or top information systems management journals. Another potential research avenue would be to carry out an empirical study to observe the occurrence of the identified network-level knowledge barriers in practice.

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No potential conflict of interest was reported by the authors.

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