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Conceptual paper

The openness of open innovation in ecosystems – Integrating innovation and management literature on knowledge linkages

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ABSTRACT

Open innovation has rendered increased interest both in practice and research, and has expanded from dyadic transfers of ideas, to ecosystem levels. Knowledge is at the heart of open innovation, and this paper describes and discusses knowledge-transfer linkages for open innovation. It does so based on a literature review. The paper links together open innovation research with general management research to categorise and discuss linkages among parties in terms of their openness and how they relate to knowledge management. Conclusions indicate that openness needs to be considered in different dimensions that also links to different knowledge management outcomes. The paper's contribution consists of how it connects open innovation research to the general management literature, and how it builds a practical understanding of how linkages between firms can be categorised to aid firms to consider which mechanisms they may choose and why.

Introduction

In today's global society, firms recognise they have much to gain from creating partnerships and engaging with the rest of the world (Huizingh, 2011; Håkansson & Snehota, 1989; Stanko, Fisher, & Bogers, 2017). Companies, both large and small are turning to open innovation on a grand scale (Chesbrough, 2006). Open innovation refers to how organisations use internal and external *sourcing* and *markets paths* for innovation, or *share innovation processes* (Gassmann & Enkel, 2004). On the inter-company level, this is accomplished through the creation of linkages, that is, systems of relationships (Reagans & McEvily, 2003) or modes of interaction (Ollila & Elmquist, 2011) between firms. Open innovation is recognised as a progression from the classical linear models of innovation, from technology-push, through supply-chains (Chapman & Corso, 2005), to network or collaboration focussed innovation (Chesbrough, 2003). With the change from linear models comes a focus towards the open and free-flow of knowledge between a range of partners and collaborators (Chesbrough, 2003). Ecosystems become means to describe this further expansion and the firm's contextual embeddedness, expanding the lens from the individual firm to its interconnectivity with other parties, and knowledge as created in symbiosis rather than only for the firm's own good (Chesbrough, Kim, & Agogino, 2014; Traitler, Watzke, & Saguy, 2011; van der Borgh, Cloodt, & Romme, 2012).

Many authors once again present small organisations as beautiful and argue that as long as they are 'effectively linked' (e.g., Ferreira, 2009; Öberg, 2012) they can compete on the global stage (Bessant & Moslein, 2011), while large organisations also adopt the open innovation paradigm. For example in 2007 a number of organisations working in the IT industry came together to create the Open Handset Alliance[1] and later to launch the globally successful 'Android' operating system and software platform. The organisations included Samsung, Intel and Qualcom (handset and component manufacturers); Google (a software developer) and T-Mobile (a mobile telephone operator) who loosely followed a vertical integration (or supply-chain) derived structure. This is a well versed example of open innovation around a multi-player venture that could be argued to be market driven – the needs of the customers (or users) creating the motivation for user-led innovation (Han et al., 2012). Other examples indicate how

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firms may collaborate on horizontal level, in terms of complementary (co-operation) and competing organisations (co-opetition) (Bengtsson & Kock, 2000), such as the 'Ecomagination' initiative that led General Electrics to collaborate with a range of smaller and less-established organisations to create emergent 'green technology' solutions (Chesbrough, 2012) and the development activity between Sony, Samsung and a number of other high-tech electronics companies which enabled them to develop core technology that was then sold by each organisation in competition with its collaborators (Gnyawali & Park, 2011).

These few examples point to how open innovation may take different forms. There is hence a wide range of company-to-company linkages that can be pursued under the auspices of open innovation (cf. Stanko et al., 2017). Each of these open innovation activities expectedly have different benefits to offer and organisations working in an open innovation paradigm, regardless of whether the process and/or the outcomes are open or closed (Huizingh, 2011), require partnerships and high value relationships that enable the free flow of information and knowledge but which one should an organisation choose? Literature describes how knowledge may be created, retained, and transferred (Argote, McEvily, & Reagans, 2003). Different linkages would expectedly enable such outcomes to different extends, and promote the transfer of tacit or explicit knowledge to various degrees (Nonaka & Takeuchi, 1995).

Open innovation entails both internal and external processes. This paper focuses on the interlink between the two, that is, how companies engage with other firms in their innovation processes, and thus targets the company-to-company linkages between firms. Different forms of interpersonal relations, cooperation, and business relationship connects, along with corporate governance structures to facilitate knowledge creation, transfer, and sharing have been described in the general management literature. This paper links together the open innovation literature with the management research to specifically focus on various linkages and their roles for knowledge transfer. This paper discusses such linkages, ways to categorise them, and connects them to knowledge transfer activity (e.g., Araújo & Teixeira, 2014). The purpose of the paper is to *describe and discuss company-to-company linkages for open innovation*. The following research questions are addressed:

- What type of company-to-company linkages are described in the management literature?
- How can they be categorised related to open innovation and ecosystems?
- How do they enable the unconstrained flow of knowledge?

The research builds a practical understanding of how the linkages between firms can be categorised to aid firms to consider which mechanism they may choose and why. There is strong seam of rhetoric within the academic literature on open innovation; however, the theoretical and empirical foundations from which to develop practical understanding of how to make and sustain linkages is less developed (cf. Vanhaverbeke & Cloodt, 2014), and the paper contributes theoretically to the innovation literature through connecting open innovation and knowledge management to the general management literature on company-to-company linkages.

The paper is structured as follows: Next, our theoretical point of departure is presented. To create a background to the study, we briefly refer to previous research on open innovation and categorisation of linkages. The paper is based on a literature review, and following the research design section, we present its findings. The different linkages are categorised and discussed in dimensions of openness and knowledge management. The paper ends with conclusions, contribution and practical implications.

Theory

Open innovation

Open innovation according to Tidd and Bessant (2009) is driven by a desire to realise: cost reduction for technology development, reduced risk for market entry, to achieve economies of scale for production, reduce lead times for product or service development, and to promote shared learning. In essence the ability to 'tap into shared creativity' is a considerable driver in the open innovation context (Bessant & Moslein, 2011) and this creates the motivation for organisations to link with other organisations as they no longer have to make or source everything themselves (cf. Doz & Hamel, 1998). With the introduction of 'collaborate' into traditional decisions of 'make' or 'buy' a company can extend its capabilities in interaction with others.

These motivations for open innovation carry several resemblances with motives described in literature on alliances, collaboration, and cooperation in the general management literature (Das & Teng, 2000; Gomes, Weber, Brown, & Tarba, 2011). That literature further elaborates on how the choice between such different options impact their outcome, and are motivated by, for instance, flexibility, control, financial requirements, and temporality (Folta, 1998; Nordin, Öberg, Kollberg, & Nord, 2010).

In considering 'opening' the process of innovation, the formative model presented by Chesbrough (2006) – see Fig. 1 shows a progression from internal (to a company) and external technology development, being funnelled towards the current market, whilst out-licensing, technology spin-offs and technology in-sourcing create revamped or entirely new products for existing and new customers. This suggests a partially linear process where new products and services are conceived and then developed as part of a collaboration activity, taking ideas and initiatives from within the organisation and outside of the organisation to create an amalgam of ideas, capabilities, competences and knowledge from the contributing partners. Enkel, Gassmann, and Chesbrough (2009) point to how processes may also be shared, hence partially leaving the linear presentation of open innovation (West & Bogers, 2013). In the suggested division of open innovation activities, we can thus distinguish between *sourcing* activities, *market path* (commercialisation), and *shared* innovation processes.

Categorisation of linkages

A linkage between companies hence relates to properties of relationships (Reagans & McEvily, 2003) or modes of interaction (Ollila & Elmquist, 2011). Researchers categorise such linkages in different ways: based on their purpose (Wilson, 1995), what is exchanged in them (Cannon & Perreault, 1999), their durability (Duffy, 2008; Rinehart, Eckert, Handfield, Page, & Atkin, 2004), and the dependence among companies (Dwyer, Schurr, & Oh, 1987; Pfeffer & Nowak, 1976), to mention a few.

A linkage may be described as temporal or continuous, it may be characterised based on the interplay between its actors: if the relationship between them is in balance or not in terms of power/dependence, conflict/cooperation, and shared/divergent goals, for instance (Corsaro & Snehota, 2011; Emerson, 1962; Gadde, 2004). Such characteristics would decide how the linkage is managed and considered by its parties (Dabholkar & Neely, 1998). A recurrent way to distinguish different linkages from one another is that of their degree of formalisation (Bengtsson, Holmqvist, & Larsson, 1998) from mergers and acquisitions to imaginary networks. This also indicates how linkages may change. A previous company-to-company linkage may, through an acquisition, be internalised while spin-offs, as described in the innovation literature, mean that an idea is separated from its source (Mustar et al.,

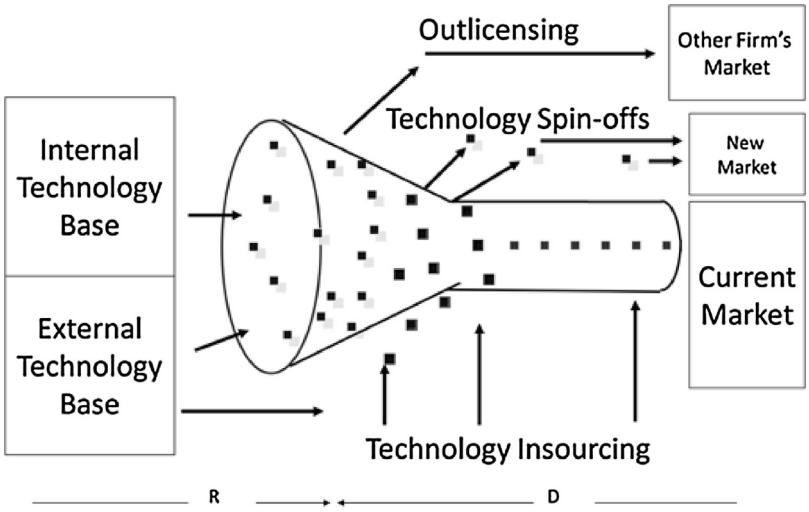

Fig. 1. Open innovation model (Chesbrough, 2012).

2006; Öberg, 2016). The idea of networks (or ecosystems) further points to how a linkage may include more than two parties (Smith & Laage-Hellman, 1992) and how these may be seen as part of the knowledge sharing or contextualise and affect such sharing, for instance.

Openness can be understood and measured in different ways. Dahlander and Gann (2010) describe a spectrum between closed innovation (where all innovation activity is undertaken behind closed doors) and the most open activity, where many actors collaborate towards a common goal, sometimes without reference to a company (for example open innovation communities developing open source software, where no one organisation owns the end product). Dahlander and Gann (2010) indicate how the inclusion of external parties makes a process an open one, but openness could also be scaled in terms of differences in competences, levels of freedom, number of actors, their continuity/flexibility. Idrissia, Amaraa, and Landrya (2012) describe openness in terms of breath and depth. This indicates that the openness is greater if the span of competences is greater among contributing parties. Herzog (2008) links openness to freedom in organisations, and Aslesen and Freel (2012) discuss it in terms of formalisation. This relates to such aspects as described in the general literature on choices between alliances, acquisitions, and related (Das & Teng, 2000). Lazzarotti and Manzini (2009), lastly, refer to openness in terms of number of parties involved and number of phases in the innovation process they participate in. This last part is similar to openness as referred to by Dahlander and Gann (2010) and points to how the more phases, the more open the process would be. In line with that argument, a shared innovation process (Enkel et al., 2009) would be more open than the sourcing or market path activities alone. In terms of number of actors, a network would according to Lazzarotti and Manzini (2009) be considered as more open than the dyadic construct between two parties (Ozkan-Canbolat & Beraha, 2016). Table 1 summarises different ways to consider openness.

Based on Table 1 it could be suggested that openness could be considered as the combination of several dimensions. A network or ecosystem that is not formalised (for instance, different actors come and go from the network or ecosystem) and includes different competences that participate in shared activities, would indicate the most far reaching openness.

In relating openness to knowledge management, different degrees of openness would suggest different foci on knowledge: whether it would need to be explicit or could be tacit, and whether it could be maintained at its original positions or needs to be transferred (De Wit, Dankbaar, & Vissers, 2007; Nonaka & Takeuchi, 1995; Reagans & McEvily, 2003). We will discuss different company-to-company linkages in these dimensions in the paper.

Research design

Data collection

The paper is based on a literature review of different company-to-company linkages for knowledge transfer. The review was conducted through a systematic search in *EBSCO Host Thesaurus* on journal articles that referred to *information transfer* and to *knowledge management* in combination with the following items to capture different forms of linkages: *interpersonal relations*, *cooperation*, *relationship marketing*, *corporate governance*, and *industrial marketing*. The combinations were chosen based on how they cover different areas in management research and further based on an explorative search in the thesaurus of the database to cover as many as possible ways to describe company-to-company linkages (the thesaurus was carefully search for possible terms and phrases). The relevance of looking within the general management literature for description of linkages is to understand how that literature has described different types of collaborations among parties for many years, and further how it motivates such constellations, which seems to be similar to motives for open innovation (Doz & Hamel, 1998; Tidd & Bessant, 2009). The initial literature search was conducted in April 2013, and was subsequently updated with the last update being performed in September 2017.

Data analysis

A total of 340 articles were scanned in their titles, abstracts, and keywords for how company-to-company linkages were described. The literature review constructed a list of different ways to refer to such linkages. These were first listed in relation to search items so as to conclude whether different research streams had different ways to refer to such linkages. In a first-round of coding of them (cf. Pratt, 2009), they were then categorised into groups regardless of their source. This coding took into consideration descriptions that were synonymous and brought such items together. Next, the different linkages were categorised in terms of whether they referred to sourcing, market path, or shared innovation activities, and what openness they described. This step of the analysis was performed

Table 1
Dimensions of openness.

Openness	Description	Scholars	In the paper defined as
Breadth	The more different the competences, the more open.	Idrissia et al. (2012)	Heterogeneity in skills of contributors (they are not the same type of actors).
Depth	The deeper the knowledge, the more open.	Idrissia et al. (2012)	Expertise of contributors is high.
Freedom, lack of formalisation	The freer the collaboration, the less formalised, the more open.	Herzog (2008), Aslesen and Freel (2012)	Arrangement based on voluntary participation. Contracts not main deal.
Number of phases	The more phases the parties are included in, the more open.	Lazzarotti and Manzini (2009)	More than one phase covered in the innovation process.
Number of actors	The more parties, the more open.	Lazzarotti and Manzini (2009)	More than two actors involved.

individually by the authors and later compared so as to reach a shared understanding and verify the categorisation.

In the attempt to provide insights into how the different linkages enabled the flow of knowledge, the linkages were compared using logic gained from previous research, as the primary mode of analysis. This enabled us to discuss knowledge as tacit or explicit, and as transferred or retained in relation to the openness of the linkages.

Findings

Company-to-company linkages

The literature search provided a list of different descriptions of linkages, see Table 2. As suggested by the table, there are some differences between different fields of research and ways to refer to linkages. *Interpersonal relations* mainly target the social ties of individuals on intra- or inter-organisational levels. In such relations, the social mobility of individuals would be important as would knowledge on individuals' levels (Leroy & Ramanantsoa, 1997). While it could be argued that these relations do not describe company-to-company linkages, they are often considered as part of such (Gulati & Harbir, 1998; Håkansson & Snehota, 1995), and further, this stream of literature also includes discussions on alliances, business networks, and the like.

Literature on *cooperation* seems frequently to suggest how company-to-company linkages are dyadic (i.e. they include only two actors). They are often formalised (Bengtsson et al., 1998) through contracts between parties. However also this group includes less formalised arrangements, temporal meetings, and communities consisting of several (i.e. more than two) parties.

The *relationship marketing* literature takes the company's advantage of creating relationships with customers as its starting point (Gummesson, Lehtinen, & Grönroos, 1997; Olkkonen, 1996). This means that the perspective taken is largely that of a supplier and company-to-company linkages focus on business transactions and customer retention, which may include the customer as a contributing party in the exchange or development of goods or services (cf. Öberg, 2010). *Corporate governance* literature discusses how a firm internalises resources or competences, or creates control in its company-to-company linkages. This literature hence deals with transformations, such as mergers and acquisitions, but also creations of new units such as joint ventures. It increasingly refers to networks and communities, however. The *industrial marketing* literature, lastly, frequently describes business transactions between retained actors. In comparison to the relationship marketing literature, it often takes a multiple-actor perspective to the business transactions or describes them on a network level (cf. Holmlund, 2004).

Categorising linkages

Based on the list produced in Table 2, some different categories of company-to-company linkages can be developed. Table 3 refers these to the division of open innovation into sourcing, market path, and shared innovation processes.

Certainly some company-to-company linkages would be valid as both sourcing and market path activities or as shared processes. One important dimension here is the perspective taken in the literature. If, as is often the case in industrial marketing literature, focus is on the network (Anderson, Håkansson, & Johanson, 1994), activities would be more often characterised as shared, while the company-focussed perspective frequently taken in relationship marketing (Gummesson, 1995; O'Malley, 2003), for instance, indicates how external parties may be used as sources for innovation, or in the creation of new market opportunities. With a focus on one party in a company-to-company linkage, there will be one party providing new ideas, and one using it as a source. A license would for one party create a market path, and for the other a sourcing option, for instance.

Looking at the division between sourcing, market path, and shared activities, the *sourcing* activities could be divided between sourcing and acquiring (Dahlander & Gann, 2010). Acquiring is the process of purchasing intellectual property, knowledge or skill from the market (e.g. in-licensing, purchase of patents). Sourcing can be explained as bringing in new knowledge or capability to a firm, without reference to a financial transaction (non-pecuniary) and might involve product development where other parties are included as sources of information, idea generation, and the like, or, attendance at conferences, reading research and trade articles and hosting best practice events etc. – the role normally undertaken by technology scouts/knowledge gatekeepers (Cranefield & Yoong, 2007).

In terms of *market path* innovation activities, these can be further divided between selling and revealing (Dahlander & Gann, 2010). Selling is the process of trading intellectual property, capability and know-how (e.g. out-licensing, patent sales). Revealing is the process of providing knowledge and expertise to the collaborators without reference to a financial transaction, or at least not at the time of transfer. This could include contributing to benchmarking initiatives or peer-to-peer learning networks such as the PROFITNET in the UK in 2004/5 or the Salinga Value Manufacturing Network in South Africa that surrounds the localised furniture industry (Bessant, Alexander, Rush, Tsekouras, & Lamming, 2012).

As for *shared* processes, these include trading, joint-venture models and shared-service models. Joint-venture models, partnerships, and shared-service agreements bind together collaborating partners to create shared delivery. An example of this was where a group of healthcare trusts in the UK created a shared HR service. The service is tied together for a period of time but is not vested into a new legal entity. Capabilities of the relative partners are combined

Table 2
Literature review – findings.

Search item	Number of articles	Ways to describe linkages	Comment
Interpersonal relations	108	Networks Social networks Individual-level mechanism Inter-unit interaction Alliance Business networks Exchange relationships Inter-organisational relationships Industrial relations Joint ventures Virtual communities	Many person-to-person networks on intra- or inter-organisational levels.
Cooperation	79	Exchange Strategic alliance Business network Industrial district Contracting out Inter-professional relations Partnership Communities Virtual community Intergroup relations Inter-organisational relations Conferences Conventions Patent	Company-to-company establishments often based on formality and including only two parties.
Relationship marketing	32	Cluster Customer relations Business-to-business transactions	From a focal firm's perspective, value creation to the benefit of customers.
Corporate governance	99	Social networks Business networks Communities Outsourcing alliance Strategic alliance Joint venture Merger Acquisition Subcontractor R&D alliance Corporate networks Inter-organisational relations Intergroup relations Partnership Customer relations Customer network relationships Value-chain network Inter-firm collaboration	Different forms of (often) formalised arrangements as sourcing options.
Industrial marketing	22	Business network B2B relationships Trade show Buyer-seller relationships Supply chain Customer relations	Business-oriented, long-term transactions where continuous exchanges rather than formalisation creates the linkage. Often multiple actors, perspective of several actors.

to create new products, services or amalgams (or 'constellations' (cf. Vargo & Lusch, 2004)) of service capability. For instance where Landmark Group, work alongside national and international data repositories to build mutually beneficial services that they both offer, by combining their service activities and resources. Joint-venture models are similar, where organisations pool their respective resources to create a new capability, but this is vested within a new legal entity, which manages itself. The International Joint Venture partnership between Mazda and Ford Motor Car Company in the US would be an example of this. Shared activities further include how knowledge is shared and interchanged for the good of the participants and not for any commercial gain, but merely to address a driver that has a common goal to the participants. For instance commercial and private pilots share a confidential safety reporting system (Aviation Safety Reporting System) where issues, incidents and mistakes can be shared to provide a knowledge-service for the benefit of the participants. This is not about a fixed end goal, but the process of sharing knowledge and capability to create a capability to undertake new activities. A further example of this is the Victoria Universities Innovation Management Network – where the 9 universities in the state of Victoria, Australia have created a wide constellation of organisations surrounding innovation management with a view to pooling their collective knowledge and developing new knowledge that will benefit all of the partners.

Linkages and openness

The theory section outlined some different dimension of openness as a further means to characterise company-to-company linkages (see Table 1). How could the different linkages found in the literature be understood in this regard?

Table 4 elaborates on the different linkages from Table 3 in terms of their openness. As suggested by the table, shared activities tend to cover more phases of the innovation process, while sourcing is mostly concerned with the early phases (search and select (Tidd & Bessant, 2009)) and market path with the later ones

Table 3
Linkages.

Open innovation	Linkages
Sourcing	Conference
	Convention
	Patent
	Acquisition
	Merger
	Subcontractor
	R&D alliance
	Customer-relation network
	Supply chain
	Value-chain network
Market path	Contracting out
	Business-to-business transaction
	Customer relationships
	Outsourcing alliance
	Trade show
Shared activity	Alliance
	Joint venture
	Partnership
	Collaboration
	Industrial district
	Industrial relationships
	Inter-group relationships
	Network
	Cluster
	Community

(predominately capture). The other dimensions of openness do not follow the division between sourcing, market path, and shared processes as closely, while we indicate a negative connection between depth and freedom (i.e. in-depth linkages would also be formal to high extent), and breadth and depth are rarely combined.

While not suggesting that each dimension is equally important for the openness or outcome, the table does point to how communities create more openness than patents, for instance. The number of players as well as contextualised or shared knowledge on the network or ecosystem level (Almirall, Lee, & Majchrzak, 2014; Pitelis, 2012; Traitler et al., 2011) provides more openness than the dyadic transfer without any knowledge exchange with others. Furthermore, it indicates how open innovation linkages and outcomes may not only be referred to as open or closed, but represent a variety of different dimensions and consequences.

Openness and knowledge management

The knowledge management literature describes knowledge as tacit or explicit, and whether it really needs to be transferred or can be maintained at its original position (Argote et al., 2003; Nonaka & Takeuchi, 1995). How can this be related to different company-to-company linkages? Looking at the different linkages, we apply two different ways to describing them. Firstly, whether they concern sourcing, market path, or shared processes (Chesbrough, 2003; Enkel et al., 2009; West & Bogers, 2013), and secondly based on their openness (e.g., Dahlander & Gann, 2010; Herzog, 2008; Idrissia et al., 2012).

If considering the first categorisation, it includes a broad range of different company-to-company linkages. In the sourcing of innovation, knowledge would for the most part expectedly need to be transferred to the in-sourcing company. This is because it is this party who takes the innovation onwards in the innovation process. The market path activities similarly include knowledge transfer into and out-of the firm. The shared process linkages would, to differing extents, allow for knowledge to be maintained at its original positions, although this varies across the linkages. In terms of whether knowledge could be tacit or explicit when transferred, according to the literature this differentiation arises from different aspects of the company-to-company linkages than sourcing, market path and shared processes, and could be a consequence of the degrees of formalisation, knowledge levels among actors, and so forth, which thus makes it relevant to connect knowledge management aspects to openness.

We thus feel it is relevant to consider knowledge management criteria in terms of openness, where different dimensions of openness would include different knowledge management strategies, and vice versa: the capabilities of the firm should decide what open innovation company-to-company linkages to engage in. High levels of knowledge among contributing actors would need to be matched with a high capability to translate and assimilate knowledge. Too dissimilar knowledge (*breadth* as criterion for openness)

Table 4
Linkages and openness.

Open innovation	Linkages	Breadth	Depth	Freedom (lack of formalisation)	Number of phases	Number of actors
Sourcing	Conference	√		√		√
	Convention		√			√
	Patent		√			
	Acquisition		√			
	Merger		√			
	Subcontractor		√			
	R&D alliance	(√)	√		(√)	√
	Customer-relation network	√		√		√
	Supply chain		√	√		(√)
	Value-chain network		√	√		√
Market path	Contracting out		√			
	Business-to-business transaction			√		
	Customer relationship			√		
	Outsourcing alliance		√			√
	Trade show	√		√		√
Shared activity	Strategic alliance	√	√		√	√
	Joint venture		√		√	
	Partnership		√	(√)	√	
	Collaboration	√	√		√	√
	Industrial district	√		√	√	√
	Industrial relationships		√		√	
	Inter-group relationships	√		√	√	
	Network	√		√	√	√
	Cluster		√	√	√	√
	Community	√	√	√	√	√

between parties could constrain or compromise the knowledge transfer (Boschma, 2005; Crescenzi, Nathan, & Rodríguez-Pose, 2016; Crespo & Vicente, 2016); parties may not contribute much to the knowledge transfer and accordingly the knowledge need to be predominately explicit. As for in-*depth* competences, this would allow for more tacit knowledge and allow for the transfer of knowledge. In terms of *freedom*, knowledge transfer, and tacit knowledge in particular has been observed to transfer more effectively in 'free' or unformalised interactions (Schmoch, Licht, & Reinhard, 2000), while the transfer (as opposed to maintaining knowledge on its original positions) would be fundamentally important related especially to how different parties play temporal roles in the innovation process. This temporality would denote a need to focus on the act of transferring knowledge, while if the linkage is formalised then knowledge flow may be easier to maintained, but is often less tacit as a result.

The *number of phases* could be linked to the temporality of actors as contributors, and indicate that knowledge may rather be maintained if the same party contributes in several phases than only in one. The *number of actors*, lastly, indicates how more actors create more complex knowledge transfer patterns, that would call for their formalisation and the need to make knowledge manifested and explicit, especially so if the different parties only contribute temporarily and based on freedom.

Conclusions

The paper describes and discusses company-to-company linkages for open innovation. It categorises and discusses such linkages in terms of their openness and how they relate to knowledge management. The introduction raised three questions that are elaborated on below.

What type of company-to-company linkages are described in the management literature?

The literature review indicates that company-to-company linkages include structured and unstructured, formal and informal, dyadic and multiple-actor constellations that may be continuous or temporal, built around a supply-chain or network paradigm and focus on the individuals or company levels of linkages. They may also transform and include creations of new businesses. The literature presents different perspective on the company-to-company linkages, fundamentally because they are derived from different research disciplines, however for open innovation to be successful an organisation must adopt a cross-disciplinary adoption strategy (Dahlander & Gann, 2010).

How can they be categorised related to open innovation and ecosystems?

Literature presents various ways to categorise linkages, and we here refer to linkages in terms of sourcing, market path, and shared processes, and in terms of dimensions of openness. Certainly other ways to categorise linkages may apply, but the description of openness in different dimensions seems to create a valid link to knowledge management, while sourcing, market path, and share processes do not seem to provide enough such guidance.

In relation to open innovation, the focus on the sourcing, market path, and shared processes (Gassmann & Enkel, 2004) is relevant, as is the degree of openness that the different linkages portray. Again, these categorisations reveal that the open innovation literature could find much theoretical support in the general management research, as several phenomena overlap. In terms of ecosystems (e.g., Almirall et al., 2014; Traitler et al., 2011), the most pronounced categorisation is the number of parties as described in relation to the degree of openness. Furthermore, the description of parties surrounding and contextualising, or them actively taking part, also relates to ecosystems. Interesting is then how the knowledge transfer and sharing may be affected based on breadth among parties, for instance, which may negatively impact the knowledge and its practice.

How do they enable the unconstrained flow of knowledge?

Less formal links seem to be positively correlated with knowledge outcome (Clauss, 2012), while the inclusion of multiple companies increasingly requires formalising mechanisms. In networks, such aspects as shared history, culture or trust may replace the needs for formal or contractual arrangements among parties. Indicatively, the more formal the links, the less the need to actually transfer knowledge to the other party (but retain it by the first one) (Lichtenthaler & Lichtenthaler, 2009). For the creation of new knowledge, social ties need to be strong, while the network linkages may be largely informal (Nonaka & Takeuchi, 1995).

Contribution

This research adds to the understanding of how companies can go about developing linkages that enable open innovation. It presents a theoretical framework to consider such linkages and it begins to establish which linkages could strengthen an organisation's capability to engage in open innovation.

For further research, the company-to-company linkages could be further developed, grouped, and re-categorised. Their relation to different dimensions of knowledge (such as knowledge on company or individuals' levels, and knowledge as homogeneous or unique for individual actors), could be further developed.

Practical implications

For companies engaging in open innovation, we know that it is important to consider who to link with and to consider carefully what these partners might provide your organisation. This paper asserts that it is equally important to consider carefully 'how' organisations should link together and we suggest that by presenting analysis of the different linkages, companies are better able to undertake this important selection.

Managers need to ask themselves about the consequences of various types of linkages for the knowledge actually achieved and the innovations developed. More specifically, the consequences of different degrees of openness and the design leading to such openness (networks/ecosystems or dyadic linkages, formalisation or informal linkages, etc.) is important to consider, as is how these facilitate knowledge transfer and sharing in different ways.

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