

Network Capabilities in Collaborative Innovation Networks

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Abstract:

This study addressed the necessary network capabilities for collaborative innovation networks. To do this, we discussed the theory of network capabilities and analyzed empirical data regarding two networks of collaborative innovation. Empirical research showed that the focal (hub) company in the collaborative innovation network needs the ability to begin, use and keep, develop, and terminate networks, as proposed by the current theory of network capabilities. In addition, it needs capacities of planning and of network responsiveness. Our findings suggest that hub firms must have network capabilities in five dimensions: planning, beginning, using and keeping, network development and responsiveness (amplitude), at three levels of action - processes, activities and routines (depth). Therefore, we contribute to the theory of network capabilities by increasing the understanding of the required network capacities for hub companies in collaborative innovation networks.

Keywords: Network capabilities; Focal (Hub) firms; Collaborative innovation networks; Clinical research.

Introduction

Management theory emphasizes that organizational networks have strategic orientation towards performance, flexibility or innovation (Powell 1990; Zhang & Gregory 2011; Zhang, Gregory & Neely 2016). In any of these strategic orientations, the network's hub company needs to carry out access routines and use of resources and capacities of other organizations (Helfat & Peteraf 2003; Ritter, Wilkinson & Johnston 2004; Walter, Auer & Ritter 2006) as a differential benefit of the organizational network (Foss 1999).

However, network capabilities for the management of collaborative innovation networks are poorly explored in management theory (Hagedoorn, Roijakkers & Kranenburg 2006; Rampersad, Quester & Troshani 2010), in spite of evidence that these networks are sources of market adaptation and competitive advantage (Sampson 2007; Faria, Lima & Santos 2010; Davis & Eisenhardt 2011). Nevertheless, they also resemble drains by losing resources and innovation capacities (Faems, Van Looy & Debackere 2005; Owen, Goldwasser, Choate & Blitz 2008; Tsai 2009). Results of previous studies are ambiguous regarding the effects of collaboration on innovation: positive, insignificant or negative (Tsai 2009). The focal company needs the ability to manage the network (Davis & Eisenhardt 2011; Tsai 2009; Zhang & Wu 2016) in order to improve the results of innovation in collaborative innovation networks, **but what are the necessary capabilities of networks and how do they express themselves in organizing the collaborative innovation network?**

Network capabilities are levels of network management practice of the hub company, and require a set of capacities to build the network value proposition. Therefore, the research unit of analysis is the hub company, and the focus is to understand its necessary and sufficient

network capabilities to manage the processes of collaboration for innovation. Our results show that there is a system of organization of network capacities in levels, through processes, activities and routines; and in addition to generic network capacities (begin, use and keep, develop and terminate), we identified the differential capacities (network planning and responsiveness), according to empirical data. Thus, we addressed part of the issues that emphasize the challenges of managing complex relationships in collaborative innovation (Johnsen & Ford 2000), since innovation performance relates to network management: to identify the need for a connection, to find the right partners, to manage the network arrangement, and to ensure the management of stresses (Rothwell & Dodgson 1991).

Network Capabilities: literature review

The concept of network capabilities reflects "a set of organizational activities and routines that are implemented at the level of the hub company in order to begin, maintain, develop and end business relationships, with guarantees and benefits" (Mitrega, Forkmann, Ramos & Henneberg 2012, p. 741). Thus, there are two theoretical dimensions for the analysis of network capacities. The first dimension regards the relationships' life cycle, and refers to the set of procedural activities to start, use and keep, develop and conclude networks (Kohtamäki, Partanen, Parida & Wincent 2013; Moller & Halinen 1999; Zhang *et al.* 2016; Walter *et al.* 2006). The second refers to the extent of each dimension of the relationships' life cycle (Foss 1999; Forkmann *et al.* 2016), because at each stage of the relationship cycle there are efficiency levels of routines that meet the network value proposition.

The first dimension of network capabilities includes the routines that aim to promote the management of the resources present in the network; the vision of the network exchange structure (in terms of learning, information, knowledge, communication); the management of the relationships' portfolio (creation and use of databases, exchange solutions, number and types of clients); and the management of network relationships (assets specificity, degree of competition, market uncertainties, attraction, trust, commitment, adaptation, conflicts, communication, cooperation, and justice) (Moller & Halinen 1999).

The second dimension of network capabilities comprises the extension of a company's network capacities (which can be understood as the amplitude of the organization's network capacities), and the activities of network management in each capacity, which can be performed at different levels of depth. Foss (1999) suggests three levels: macro, meso and micro. At the macro level are the generic capabilities, inherent to all networks, according to the phase of the relationship cycle in the network: begin, maintain, develop and terminate (Mitrega *et al.* 2012). The meso level capacities are dimensions of intermediary capabilities (resources, coordination, learning, prospecting, and attracting partners) (Moller, Rajala & Svahn 2005; Walter *et al.* 2006). Finally, network capacities at the micro level are the dimensions linked to the broader level of heterogeneity in collective interaction and in routines, implemented in the hub organization (Forkmann *et al.* 2016).

Thus, the literature review on network capabilities shows that the set of dimensions of network capacities (amplitude), in their micro, meso and macro (depth) dimensions, are responsible for composing the network management capacity. The articles that we examined highlight that network capacities can make the relationships between partners less heterogeneous and conflicting, affecting the network results (Hagedoorn *et al.* 2006; Kohtamäki *et al.* 2013; Mahmood, Zhu & Zajac, 2010; Rothaermel & Hess 2007; Sisodiya, Johnson & Grégoire 2013; Vesalainen & Hakala 2014; Zhang *et al.* 2016; Zhang & Wu 2017; Walter *et al.* 2006).

However, organizational networks present different strategic orientations (Zhang & Gregory 2011; Zhang *et al.* 2016), and the set of resources and variety of partnerships of

different networks can distinguish the type of capacities required (Hagedoorn *et al.* 2006; Moller & Rajala 2007; Zhang *et al.* 2016). Nevertheless, there is no identification of convergences and asymmetries of these different strategic orientations (Hagedoorn *et al.* 2006). Therefore, little is known about how network capabilities vary according to the network's strategic orientation, such as those oriented towards innovation.

Several authors believe, at least partly, that the presence of network capabilities can explain why companies are getting unsatisfactory results from collaborative innovation, while others achieve the planned goals (Davis & Eisenhardt 2011). This is because network capabilities help to overcome the challenges of relationship management in collaborative innovation (Johnsen & Ford 2000). This confirms the argument that only by solving network management problems a satisfactory innovation performance will come out (Rothwell & Dodgson 1991).

This is the context where we sought empirical evidence of the role of network capacities in the management of collaborative innovation networks, and tried to systematize knowledge about the depth (level) and breadth (network extension) of the network capacities necessary for the management practices of collaborative innovation networks, which was the main objective of the research. To do this, we employed the framework of network capabilities previously proposed, to understand the management of these networks, and which of these capacities companies really use.

Method

We used the qualitative approach with an inductive case study strategy to analyze two clinical research networks, at the interface of the hospital and pharmaceutical sectors. We collected data through semi-structured interviews, to distinguish the essential network capacities, without which the hub company cannot manage the network, from those that are appropriate, which increase the quality of network management. We chose the case study approach in order to achieve a deep understanding of the phenomenon, an attribute of qualitative methods (Denzin & Lincoln 1998). In addition, case studies allow a greater clarity of the boundaries between the phenomenon and the context (Yin 2001), thus enabling theory generation through the understanding of real practices, in an inductive way (Eisenhardt 1989).

The hub organization chosen for the empirical analysis of network capacities takes part in collaborative innovation networks in the health area, specifically networks that support the biotechnology industry. We justify the contextual delimitation of the research object by its R&D intensity and the level of technological sophistication, which positively correlate with the intensity and number of alliances (Freeman 1991; Hagedoorn 1995; Powell, Koput & Smith-Doerr 1996). Another feature is that biotechnology companies, despite representing a relatively young industrial sector, present an innovation performance similar to high maturity innovative industries. The performance and speed of innovation of these companies are due to the use of strategic alliances and collaboration in all stages of the innovation process (Terziovski & Morgan 2006).

Thus, we focused our analysis in the collaboration during the process of network innovation, with open entries and closed exits (Huizingh, 2011), in clinical trials. These are part of the drug innovation project, and follow the phases of molecule invention and preclinical tests, before the stages of approval, registration and sale. Even though this cutting in the analysis is a limitation regarding the overall scope of the project, if we consider that the research focus is the performance of the collaboration project for innovation, the clinical phase presents a higher multidirectional interaction between the partners, under the conditions of a collaborative network. Therefore, it is the stage that requires more of the hub company, in terms of management capabilities regarding the relationships with the partners.

Results

Theory shows that network capacities are composed by a set of dimensions that have levels in network processes, activities and routines, and empirical data confirm the capacities for beginning, using and keeping, developing and terminating networks, besides the emergence of two new dimensions that we named 'capabilities for planning network relationships' and 'network responsiveness'.

The research proposition, which points to the way network capacities manifest themselves to organize the collaborative innovation networks, allows a counterpoint between current theory and empirical data. There are differences between CASE I and CASE II data. CASE I, although presenting dimensions of capabilities, these are institutionalized in a fewer number of routines, differently from CASE II, which has a wider portfolio of institutionalized network capacities' routines. These analyses confirm the organization of the practices of network capabilities in collaborative innovation networks, in a system of levels of utilization of the set of dimensions and routines, to create the capacity to manage networks.

Hence, at the same time that we identified additional dimensions of network capabilities, we confirmed the presence of those capacities highlighted by theory in CASES I and II, although CASE II has network capacities' routines deeper than CASE I. The cases show that there are different levels of depth in institutionalized routines; consequently, different levels of network capacities. Table 1 presents and summarizes the level of adequacy of each dimension identified in the cases compared to literature, according to the analysis of each case.

Table 1

Data analysis

Construct	Category of Analysis	Comparison of the Adequacy of Network Capacities (CRs)	THEORY CRs	CASE I	CASE II
Network Planning	Planning of relationships in the network	Activities for building objectives through the relationships (purpose).	○	◐	●
		Activities regarding positioning of relationships (way).	○	◐	●
		Activities regarding relationships' strategy (means).	○	◐	●
		Activities regarding relationships' actions (action).	○	◐	●
Begin Networks	Management of the relationships' portfolio	Activities for prospecting partners.	●	◐	●
		Activities for attracting/capturing partners.	●	◐	●
		Activities for selecting partners.	●	◐	●
		Activities for agreement with partners	●	◐	●
Use and Keep Networks	Network vision	Activities to structure the network (size, density, proximity, diversity).	●	●	●
		Activities of network information and communication.	●	●	●
		Activities of network learning.	●	●	●
	Management of relationships	Activities of knowledge and assessment of network relationships.	●	●	●
		Relational activities.	●	●	●
		Activities of conflict resolution.	●	●	●
	Network coordination	Activities of network coordination.	●	●	●
		Activities of network integration.	●	●	●
		Activities of processes' adaptation.	●	●	●

	Management of network resources	Activities of capture and capitalization of resources (tangible and intangible).	●	●	●
		Activities of use and distribution of resources in the network.	●	●	●
Develop Networks	Network adaptation and adjustments	Activities for sharing knowledge and information.	●	◐	●
		Communication activities.	●	◐	●
		Activities for sharing risks and benefits	●	◐	●
	Development of relationships	Activities for expanding relationships.	●	○	◐
Terminate Networks	Partners recovery	Activities for evaluating the value of relationship.	●	○	○
	Contract termination	Activities to formalize termination	●	○	○
Responsiveness	Network responsiveness	Activities for directing partners.	○	◐	●
		Activities of partners' autonomy.	○	◐	●
		Activities of partners' assertion	○	◐	●
		Activities to support partners' results.	○	◐	●

Note. ● present; ◐ partially present; ○ absent.

Empirical findings strengthen the classification system of network capacities at practice levels, which we called 'the amplitude of network capabilities'. They are relevant dimensions in three areas of network management: in network formation, from the beginning to the termination of network relationships, and in network responsiveness. Just as important as starting, using and keeping, developing and terminating a network is to plan its relationships and be sure of its responsiveness. It is the institutionalization levels of the blocks of routines, activities and processes of network capacities (amplitude), in different degrees of depth of the institutionalization of these capacities in the hub company, that make up a certain dimension of the network capacities (depth of dimensions' use). Therefore, the breadth and depth of network capabilities in collaborative innovation networks are important, but depth is required in the dimension 'capacity to use and keep networks'. The other dimensions are also necessary, but there is no demand for depth of institutionalized routines.

Empirical data suggest that the network planning capacity is associated to the conditions of mobility of the actors in the creation of networks focused on innovation projects, since part of the actors change with each project. In addition, they refer to the development routines of the objectives of network relationship, as a means of putting into operation the network value proposition, through future relationships. The planning of the relationship emerges from the incentives and demands of the hub company to find partners with mutual interests in collaborative processes, which is necessary before building the relationship in the network. The expected impact of the planning capacity of network relationships is to strengthen their life cycle capabilities, by enhancing the assertiveness of future relationships, with *ex-ante* effects.

On the other hand, network responsiveness is associated with adverse events likely to occur in clinical trials, since the drug under test does not present all safety requirements yet, and there may be unexpected reactions. In addition, the patient's clinical condition and response to the tests can cause deviations in the project protocol, which demands an immediate response from the network. The dimension that indicates responsiveness in collaborative innovation projects has also the function of facilitating the relationship in the network, and the participation dimension of this capacity in strengthening the network acts as a bidimensional capacity. As the collaborative innovation network requires from participants to manage the stages of the innovation project, responsiveness refers to the promotion of attitudes, behaviors and protocols.

These aim to guarantee the change of partners, while keeping the network level of management, with the development of autonomy and self-assertion of the partners responsible for any stage of the collaborative innovation project, whether in the sphere of relationships or resources.

Thus, we noticed that the dimensions of network capacities tend to be strengthened through a sequence of activities and routines that compose them, in order to build the set of network capabilities needed to manage the collaborative innovation network.

Final Remarks

We believe that each of the four dimensions of network capabilities addressed by management literature (beginning, using/keeping, developing, and terminating networks) are necessary for the hub company to manage collaborative innovation networks, but they are not sufficient. Specifically, our study indicates that in addition to the network capabilities previously mentioned, the adequacy of these capacities in collaborative innovation networks is associated with network planning capabilities and network responsiveness.

Empirical evidence shows that network capabilities exceed the theoretical grouping, and therefore it was possible to explore classification levels of network capacities in networks of collaborative innovation, ranking them in a multidimensional framework: generic and intermediate network capacities, and micro foundations. The set of dimensions of network capabilities act as facilitators in building the network value of collaborative innovation networks. In addition, these can be managed through the dimensions of relationships' planning capacities, of initiating, using/keeping, developing, terminating, and network responsiveness, and they compose the global capacity of network management, when combined in breadth and depth at the macro, meso and micro levels of network capabilities.

Hence, this study contributes to the theoretical knowledge on network capacities by showing that they are elements formed in the routines of network management, with variations in operational constructs, according to the strategic orientation and the structural typology of the network. It also strengthens the proposition that there are levels of requirements and use of network capacities in dimensions' extension (amplitude) and in routine levels (depth), besides organizing a classification system of network capacities based on the levels of network use.

Although in an early way, this is the first theoretical approach in the literature of network capabilities that provides a classification system for the levels of institutionalization of these capacities, and has identified two new dimensions in networks of collaborative innovation that were not addressed before - the capabilities of planning relationships and network responsiveness.

However, there were limitations regarding the "biotechnology sector" context, especially the Centers or Units of Clinical Research, as well as the choice of the phase of the network project, the clinical trials. There are limitations of the method, due to the absence of interviews with partners of the external network, since we collected data from participants of the internal and shared network, but an external vision could bring additional relevant data.

Therefore, we expect that future studies will extend knowledge on several issues: (1) the dimensions of network capacities, from the degree of network flexibility and levels of uncertainty; (2) evaluation of the role of the level of institutionalization of activities and routines of network capacities; (3) identification of the impact of network capabilities on network performance and collaborative innovation projects; (4) understanding if the amplitude and depth of network capability dimensions affect the hub company's lifecycle in network phases (growth vs. downturn); and (5) identification of how the hub company's culture affects the use of network capabilities, and if other contexts of collaborative innovation networks present different demands of network capabilities, in addition to replicating this research in other collaborative innovation networks.

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