

Inter-organizational Relationship and Innovation: A Review of Literature

Mina Najafian and Amir Mohammad Colabi
Faculty of Entrepreneurship, University of Tehran, Iran
* Corresponding author Email: mnajafian@ut.ac.ir

Abstract

Purpose: The purpose of this paper is to present a systematic review of research linking the networking of firms with their innovation and specify the different dimensions of previous research on the subject and identify the gaps.

Design/methodology/approach: A review of the literature on innovation in networks is undertaken using the Scopus database. These keywords: 1) Inter-organizational network, 2) Organizational network, 3) Innovation, 4) Innovative Performance were searched in the title, abstract and keywords of papers.

Findings: Our review revealed that the papers were mainly trying to address or explain four phenomena: (1) the impact of networks on innovation and theoretical and empirical evidences of this impact; (2) management of networks (3) structure and content of networks; (4) formation and configuration of networks. These categories are not mutually exclusive but would help us to organize the fragmented literature on the topic. In each category some specific subjects have been the focus of analysis and some special issues have been neglected. For instance there is a need for exploration of the impact of different contents of networks on innovation compare to each other.

Originality/value: Research on inter-organizational networks is generally fragmented which hinders a better understanding of the field. This article reviews and discusses the empirical literature on inter-organizational networks and innovation and shows the current state of research and highlights the gaps.

Keywords: Inter-organizational Network, Innovation, Literature Review, Network Management, Network Configuration, Network Structure

Paper type: Literature Review

Introduction

The network approach is not new. It dates back to the 1930s in organizational studies but also owes much to its founding disciplines and conceptual origins, namely sociology, anthropology and role theory (Jack, 2010). The network concept has captured a special position in the scientific literature of business, organization, entrepreneurship and management.

This is one of the important factors that lead to improvement of business performance (Li, Cui & Li, 2008). Networks provide access to resources like capital (Aldrich & Zimmer, 1987), power and influence (Sousa et al., 2008). Organizations need different relations to gain access to knowledge and information about innovations, investors and markets (Aldrich and Martinez, 2000).

Inter-organizational networks and their effects on firms' capability and performance has been subject of many researches in the area of network studies. But, there is not a clear and widely accepted definition of this concept mainly because this term has a metaphorical origin and also different disciplines have used it frequently in their research approaches. (Borgatti et al., 2009). The term network is not always used to describe the inter-organizational relations. Many who study business, community, and other organizational networks use terms partnerships, strategic alliances, inter-organizational relationships, coalitions, cooperative arrangements, or collaborative agreements (Provan et al., 2007). In inter-organizational research, "networks" can refer to as different phenomena such as whole networks, interlocks and strictly dyadic relations (Borgatti et al., 2009). Many, in particular those tying their work to resource dependence theory and transaction cost economics or researching inter-organizational contracts also focus only on dyads (relationships between two organizations) (Provan et al., 2007). One of the most widely accepted definitions in the social network analysis literature defines networks as "a set of nodes (e.g. persons, organizations) linked by a set of social relationships (e.g. Friendships, transfer of funds, overlapping membership) of a specified type" (Borgatti et al., 2009). Despite differences, nearly all definitions refer to certain common themes, including social interaction (of individuals acting on behalf of their organizations), relationships, connectedness, collaboration, collective action, trust, and cooperation (Provan et al., 2007). Network research can involve the study of a wide range of features and aspects such as network size, structure, interactional processes, influences, behaviors and skills and this might be an advantage and also a constraint (Jack, 2010).

In recent years, the inter-organizational networks have gained attention of innovation researchers. Inter-organizational networks have been identified as one of the critical success factors in implementation of innovations. Innovation is development and implementation of new ideas (Van de Ven, 1986). Innovations are increasingly taking place in networks, in which actors with different backgrounds are involved (Kallio et al., 2010). When the knowledge base of an industry is both complex and expanding and the sources of expertise are widely dispersed, the locus of innovation will be found in networks of learning, rather than in individual firms (Powell et al., 1996). Rothwell (1977) gave strong support to the idea that success in innovation has to do with long-term relationships and close interaction with agents external to the firm. This is particularly evident in small knowledge intensive firms which have few resources (Jenssen & Nybakk, 2013). Soh and Roberts (2003) Believe that empirical investigation of an integrated framework on networks of innovators is important because the convergence of open systems technologies in the recent years has intensified the collaboration efforts among competing firms and increased the number of joint product developments significantly.

A number of literature reviews have been done on inter-organizational networks. Oliver and Ebers (1998) conducted a review of previous research in the field of inter-organizational relationships. They identified four approaches in the studies including social network, power and control, institutional, institutional economics and strategy. Pittaway (2004) performed a deep literature review linking firm's capacity for innovation with their networking behavior. They extracted networking benefits from

studies in their review set and conclude that networking activities are important factors in firm's innovative performance.

Provan et al. (2007) conducted a review on empirical studies on inter-organizational networks with the whole network as the level of analysis. They discussed that many features and aspects of whole networks such as structure and governance mechanisms should be the subject of future research.

Bergenholtz and Waldstrøm (2011), in their literature review focused on the methodological issues of studying inter-organizational networks. They made a distinction between studying network as a type of social structure with quantifiable features and studying network as description of interaction among organizations. Their concluding point is based on the concept of network taken into account in previous research and methodologies used such as Social Network Analysis.

Jenssen and Nybakk(2013), based on a literature review on the relation between inter-organizational networks and innovation in the small knowledge intensive enterprises, argued that the innovative performance of firms is considerably affected by inter-organizational networks and this is more evident in small knowledge intensive firms which have fewer resources. They discussed some moderating variables for this relationship such as firm's size.

Popp et al. (2013), proposed a critical review of research on inter-organizational network. They categorized their findings in six themes including networking concepts and characteristics, types and functions of networks, governance and structure of networks, network evolution through time, network effectiveness and evaluation of networks.

Despite the vast body of literature in studying the effect of inter-organizational networks on innovative performance of the firms, the lack of a unified framework for integrating different aspects of inter-organizational networks and their main features through which innovation is affected, is evident. In this regard, literature reviews can play an important role. As Copper (1988) states, literature reviews help in social scientists' definition of knowledge. The increasing number of papers and scholars with different viewpoints necessitate collecting, comparing and synthesizing the scholarly findings (cooper, 1988) in order to identify current body of knowledge and also aspects of the phenomenon which are still unknown.

So, the current research conducts a deep literature review to examine the fragmented knowledge about how the innovation in firms is influenced by inter-organizational networks and presents an integrative framework for this body of knowledge. In this manuscript we seek to answer two critical questions: 1- Which aspects of inter-organizational networks have been subject of inquiry in previous studies? And 2- What is the theoretical gap that should be the subject of future scholarly endeavors? In this study we don't seek to synthesis previous findings in a way done in meta-analysis. Nor do we follow a specific point of view for evaluating research designs and findings. Instead, we try to achieve neutral representation (Cooper, 1988). According to Cooper's taxonomy of literature reviews(1988), the main goal of this review is to identify critical issues central to the field, questions that have been the focus of previous research and topics that have been neglected. Also, the current research tries to specify some methodological problems which have prevented the formation of an integrated body of knowledge in the field. In reviewing the literature the focus is mostly on the findings of articles and methods used in data collection. Although this review targets network researchers as the main audience and explores theoretical and empirical issues relevant to academic research, there are important practical considerations as well.

Method

To study the academic literature on effects of inter-organizational networks on innovation, the Scopus database was used to search on these keywords: 1) Inter-organizational network, 2) Organizational network, 3) Innovation, 4) Innovative Performance. These keywords were searched in the title, abstract and keywords of papers. It led to 867 results. We filtered this list based on journal name and only included those academic articles that had published in Top 20 business Journal in English (based on Journal citation report of Thompson Reuters) and Top 10 innovation management journals (Manchester University's Institute of Innovation Research). The combination of these two journal groups resulted in following titles: Academy of Management Review, Academy of Management Journal, Journal of Marketing, Journal of Management, Journal of Management studies, Administrative Science Quarterly, Journal of Organizational Behavior, Strategic Management Journal, Academy of Management Perspective, International Journal of Management Review, Journal of International Business studies, Journal of Consumer Behavior, Journal of Business Venturing, Journal of International Marketing, Journal of Retailing, Journal of Service Research, Journal of the Academy of Marketing Science, Family business review, Entrepreneurship Theory and Practice, Journal of Marketing Research, R & D Management, Industry and Innovation, International Journal of Innovation Management, Technovation, Creativity and Innovation Management, European Journal of Innovation Management, International Journal of Innovation and Learning, Research Policy.

This filtering procedure produced a list of 116 articles and finally the papers were selected by the relevance of their abstracts. We also investigated the reference sections of these papers to include potential articles. We used this criterion for selecting the papers: The main objective of the paper should be studying the effect of a variation of inter-organizational relation between firms on innovative performance. This review of abstracts finally gave us a list of 24 related articles. Table 1 provides a summary of selected papers based on procedure described. The organizations of remaining part of this article are as follows: In the next section we provide some insight on the current state of the literature. Next, in discussion section we do a categorization base on the reviewed papers and finally provide some suggestion for future research.

Table 1: Summary and comparison of reviewed papers

Author	Year	Sector	Type of Analysis	Data	Key Findings
Thorgren et al.	2009	Multi Sector	Survey	longitudinal	Larger networks and bottom-up formed networks achieve greater innovative performance, and the administrative function partially mediates these effects.
Rejeb-Khachlouf, Mezghani and Qu��lin	2011	export consortia	Survey	Cross section	Inter-organizational transfer of good practices is facilitated by absorptive capacity of individuals in personal networks.
Huggins R., Johnston A., Thompson P.	2012	Knowledge based	Survey	Cross section	The innovation performance of firms is significantly related to network capital investment in dynamically configured inter-organizational knowledge alliances
Ceci F., Iubatti D.	2012	automotive	content analysis	Cross section	The coexistence of personal and professional relationships shapes a unique context that alters the usual dynamics of innovation diffusion

Author	Year	Sector	Type of Analysis	Data	Key Findings
Gardet and Mothe	2012	Multi sector	Qualitative- Case study	Cross section	In SMEs' innovation networks the coordination mechanisms is influenced by the size of the hub firm and its dependency.
Fichter K.	2009	machinery and industrial equipment manufacturing, chemical, the information and telecommunications, solar industry	multiple case-study	Cross section	Transformational leaders as promoters, and especially their close and informal co-operation across functional and organizational boundaries, play a key role in Open Innovation.
Wincent J., Anokhin S., Boter H.	2009	Multi sector	survey	longitudinal	Renewal rates among network board officers is an important determinants of improvements in innovative performance of firm in open innovation networks
Mohannak K.	2007	Biotechnology, information and communication technology (ICT)	Survey	Cross sectional	R&D through collaboration and networking leads to higher turn over and employment
Kodama M.	2007	Telecommunication	Case Study (Participant Observation)	longitudinal data	Formation of strategic communities leads to development of dynamic capabilities which is needed for knowledge creation. Innovation emerges from pragmatic boundaries with professionals in various specialized fields inside and outside the corporation.
Taatila V.P., Suomala J., Siltala R., Keskinen S.	2006		conceptual		Proposing a framework for analyzing aspects of innovation process specially network aspects
Obstfeld D.	2005	automotive	SNA and Survey	Cross sectional	A tertius iungens orientation, dense social networks, and diverse social knowledge predict involvement in innovation.
Salman N., Saives A.-L.	2005	Bio Technology	SNA and Survey	Cross sectional	The number of indirect ties increases a firm's innovative capability, there is a positive relationship between the degree of centrality, eigenvector centrality and innovation
Dewick P., Miozzo M.	2004	Construction	Survey	Cross sectional	The interactions and interdependencies between organizations (including contractors, government, clients, designers, sub-contractors and suppliers) clearly have an important role in shaping the process of production and innovation.

Author	Year	Sector	Type of Analysis	Data	Key Findings
Autio E., Hameri A.-P., Vuola O.	2004	Nano- technology, Metallurgy, Power electronics	Multiple case study	longitudinal data	Big-science centers offer as a source of knowledge spillovers in national innovation systems.
Soh P.-H., Roberts E.B.	2003	Telecommu nication	Survey of 150 firms and 319 alliances agreeme nts	longitudinal data	Early adoption of new technologies reinforces the central position for both firms with core ad peripheral sub systems in technology innovation networks.
Coles A.-M., Harris L., Dickson K.	2005	Defense	Multiple Case Study	longitudinal	Effective functioning of the overall product development network is closely allied to established processes within the participating firms.
Goes J B, Park S H	1997	Hospital services	Survey	Cross sectional	Level of resource exchange among hospitals and institutional links are predictors of service innovation
Powell W.W., Koput K.W., Smith-Doerr L.	1996	Bio Technology	Survey	longitudinal data	When the knowledge base of an industry is both complex and expanding and the sources of expertise are widely dispersed, the locus of innovation will be found in networks of learning, rather than in individual firms.
Stuart T E.	2000	Semiconduc tor production	survey	Cross sectional	Technology alliances with large and innovative partners improves innovation and growth rates, but collaborations with small and technologically unsophisticated partners has an immaterial effect on performance.
Hanna and Walsh	2002	Small firms	Survey	Cross sectional	Networking among small firms is primarily a competitive response. Evolving to innovation needs a mechanism to enable small firms to develop innovative products and processes.
Ritter and Gemunden	2003	mechanical and electrical engineering, measurmen t technology and control engineering	Survey	Cross sectional	The degree of innovation success is driven by technological interweavement and network competence which in turn is formed by qualifications and task execution.
Ojasalo	2008	Software	Multiple Case study	Cross sectional	Characteristic of management of innovation networks are rewards from the network; fundamental meaning of the network; the nature of the networked organization; planning, control, and trust; and hierarchies, authority, and coordination.

Results

A similar search by the key words was performed using the EBSCO database. It was found that from 1980 up to December 2013 terms inter-organizational network and

innovation had been included in 636 articles in academic journals. The same trend was shown for Conference articles. As figure 1 indicates the interest in the subject has been increased in recent years. Rapid growth of this concept in the literature may be the result of advances in information and communication technologies which facilitate inter-organizational relations in reality.

Since 1980, the number of publications in the fields of Business, Management and Organizational studies (as reported in EBSCO's Subject Category field) with terms innovation and inter-organizational network grew at an average 10 per cent per year from around 3 in 1980 to around 40 per year in 2013.

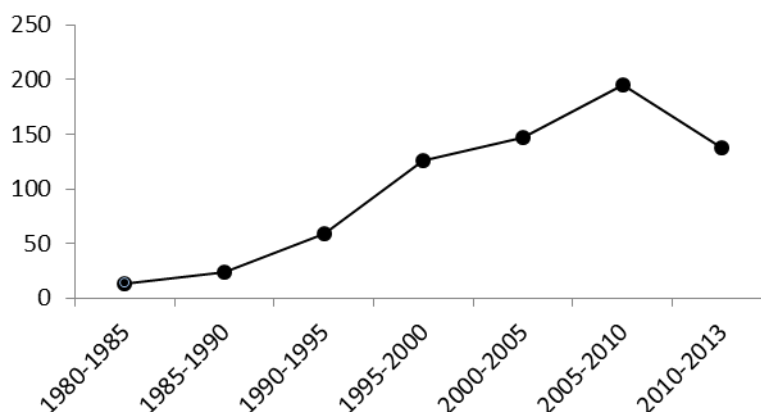


Figure 1: Number of Publication on the subject of Inter-organizational Networks and Innovation

At a general level, network has been referred to as partnerships, strategic alliances, interorganizational relationships, coalitions, cooperative arrangements, collaborative agreements (Provan et al., 2007) or any type of inter-organizational relations (Oliver & Eber, 1998). However, the inter-organizational network relationships is often studied without an explicit definition of the construct. The most agreed upon definition in the social network analysis literature (Bergenholtz & Waldstrom, 2011) define network as a set of nodes linked by a set of social relationships of a specified type (Laumann et al., 1978).

In our consideration set more than one fourth (about 26 percent) had not defined the concept at all, taken the meaning more or less for granted. More than half (about 56 percent) had conceptualized or defined the concept implicitly. The remaining publications (only about 17 percent) had explicit definition of network. Furthermore, existing definitions makes it possible for some different interpretations. Table 2 shows the definition in the reviewed papers.

Table 2: Definition of network in paper reviewed

Definitions	Authors	Year
<u>Implicit definition:</u>		
collaborative dyads	Autio, Hameri & Vuola	2004
Employees in both firms interacting both at formal and informal levels.	Coles, Harris & Dickson	2003
Informal long term relationships.	Dewick & Miozzo	2004

Close and informal co-operation across functional and organizational boundaries.	Fichter	2009
Interorganizational relationships.	Gardet & Mothe	2012
Co-operation between firms in certain activities such as marketing, purchasing, R&D, training or manufacturing.	Hanna & Walsh	2002
Social connections between people, and the ideas and resources they carry.	Obstfeld	2005
Interorganizational collaborations.	Lane & Probert	2007
Persons with whom an individual maintains a direct relation.	Rajeb-Khachlouf, Mezghani & Quelin	2011
Close relationships with customers, suppliers, research institutions, and competitors.	Ritter & Gemunden	2003
External organizational relationships that firms maintain with numerous kinds of partners such as universities, public laboratories.	Salman & Saives	2005
Alliances intended for technology transfer and joint product development.	Soh & Roberts	2003
Agreements between two firms in the industry.	Stuart	2000
<u>Explicit definitions:</u>		
A network has been defined as a hybrid coordination mechanism of economic activity that combines the advantages of both the traditional governance mechanisms of vertical integration and market Exchanges.	Ceci & Lubatti	2012
Interorganizational links-cooperative relationships among distinct but related organizations.	Goes & Park	1997
A business network consists of “nodes” or positions (occupied by firms, households, strategic business units inside a diversified concern, trade associations, and other types of organizations) and “links” manifested by interaction between positions.	Ojasalo	2008
Intentionally formed groups of small- and medium sized profit-oriented companies in which the firms: (1) are geographically proximate, (2) operate within the same industry, potentially sharing inputs and outputs, and (3) undertake direct interactions with each other for specific business outcomes	Thorgren, Wincent & Ortqvist	2009

In our paper set, conceptual papers represented only about 4 percent. Most of the papers had nothing to do with theory building. The largest share was for empirical papers, which had focused mostly on testing the relationship between networks and innovation (95.7 per cent).

According to Gopalakrishnan and Damanpour (1997) innovation is a multidimensional construct and has different aspects such as level of analysis that could be whether industry, firm, or subunit; stage of innovation process that could be whether idea generation, development, and commercialization, and type of innovation that could be product innovation or process innovation or technical or managerial innovation; level of innovation that could be radical or incremental. We used similar dimensions to analyze and compare papers in our review set. Along these dimensions we used other variables to have better description of the status of research in this field.

Our analysis of the results revealed that more than half of the papers had not talked about originality and level of innovation they were concerned with in their analysis. Among those papers in which the level of innovation was clear the bigger share was captured by radical innovation (about 30 percent). In half of the cases innovation was measured at the firm level. The next biggest share was capture by papers which analyzed innovation at level of the whole network. There were also few papers which treated innovation as an industry level phenomenon. Papers with level of analysis at firm unit had the least number.

In our consideration set most of the empirical papers had gathered data from high-tech industries (about 40 percent), near one third of the papers were concerned with multiple industries and fewer papers had focused on low tech ones. Furthermore, most of these empirical researches were performed in Europe. America captures the second biggest share. A few empirical researches were performed in more than one continent.

In some of the cases the type of innovation analyzed in the paper was not specified. Most of papers in the set had dealt with product innovation (about 65 percent). The next type of innovation which has been the concern of many papers is process innovation. After that technical innovation has been analyzed in more than one fourth of the papers. The least consideration has been given to managerial innovation.

Most of the papers in the set had focused on final phase of innovation that is commercialization or implementation and performance of innovation. But there is no much difference between the numbers of papers in each of the stages of innovation. Table 3 shows a better comparison of the papers reviewed.

Table 3: Analysis of papers reviewed

Variable	Number of papers	% of sample
<u>Empirical</u>		
Conceptual	1	4.3
empirical	22	95.7
<u>Level of innovation</u>		
Radical	7	30.4
Incremental	4	17.4
N/A	12	52.2
<u>Level of analysis</u>		
Whole network	8	34.8
Firm	12	52.2
Firm unit	1	4.3

industry	2	8.7
<u>Type of industry</u>		
High-tech	9	40.9
Low-tech	4	18.2
multiple	7	31.8
N/A	2	9.1
<u>Stage of innovation</u>		
Idea/technology	9	39.1
Development	8	34.8
Commercialization/implementation/performance	10	43.5
N/A	3	13
<u>Geography</u>		
America	6	27.3
Asia	1	4.5
Europe	10	45.5
Australia	1	4.5
Africa	1	4.5
International	2	9.1
N/A	1	4.5
<u>Type of innovation</u>		
Product	15	65.2
Process	8	34.8
Technical	6	26.1
Managerial	3	13
N/A	3	13

In their review of the literature Pittaway et al. (2004) extract twelve main themes that the publications on innovation networks were centered around. Our review further revealed that the papers were mainly trying to address or explain four phenomena: (1) the impact of networks on innovation and theoretical and empirical evidences of this impact; (2) management of networks (3) structure and content of networks; (4) formation and configuration of networks. These categories are not mutually exclusive but would help us to organize the fragmented literature on the topic.

1. The Impact of Networks on Innovation

There is an increasing interest in investigating the role of networks in innovation. It has been proposed that the process of innovation is very complex and no longer is a single firm able to conduct such a process. The firm needs to have contacts with external actors (Chesbrough, 2003). Therefore, Some articles have emphasized on learning as a result of network relations (Dougherty and Hardy, 1996), many have focused on resource sharing that happens in networks while others have taken into account the network capital (Huggins et al., 2012). The literature suggests effective new product development through alliance-building (Kahn, 1996). For example Huggins et al. (2012) studied the role of inter-organizational networks as facilitators of knowledge flow and innovation. They carried out a survey of 181 knowledge-based firms across the three regions in Turkey. In their conceptual model, inter-organizational network forms that facilitate knowledge flow are configured according to both the geographic space and network space occupied by network actors. This configuration is associated with characteristics of particular firms and those of the regional spaces in which they are located. They believe that the nature of the inter-organizational network formed within

and across different spaces associated with the innovation performance of constituent network. To measure innovation, they counted the number of new products and processes developed or adopted in the previous three-year period in each firm. Finally they found significant differences across regions and cross-regional commonalities in terms of the association between the innovation powers of firms and the nature of their networks. They also found that the innovation performance of firms is significantly related to network capital investment in dynamically configured inter-organizational knowledge alliances.

In a different research Autio et al. (2003) employed the social network, social capital, and inter-organizational learning theories to examine knowledge spillovers accruing to industrial partner companies in big-science–industry dyads. They used the multiple case study method in the context of big-science centers during the period of 1996–2001 and followed grounded theory approach to develop propositions regarding Cognitive social capital (shared language, symbols, goals, vision), Structural social capital (access to social networks), Relational social capital (trust, liking, norms of reciprocity, socialization), Learning potential and Innovation benefits in the context of big-science and found evidence for their propositions. Finally they implied that Big-science can act as an important first customer for emerging technologies and can be leveraged in all phase of the innovation Trajectory. Furthermore the concluded that Big-science centers can be leveraged for advancing development projects and even though they may not always be financially lucrative, but technological learning benefits may outweigh financial ones.

Kodama (2007) presented a framework in which the integration of various organizational boundaries between heterogeneous organizations both inside and outside a corporation creates new knowledge. During a long-term observation as a participant in a mobile communications company in Japan, he employed the participant observation method to investigate the dynamism in which new knowledge is created by simultaneously promoting the forming of a horizontally integrated network among strategic communities between the two corporations including customers and a vertically integrated network among strategic communities with the corporation. Finally he concluded that one of the keys to producing innovation in a knowledge-based society is how companies can organically and innovatively network different knowledge created from the formation of a variety of strategic communities both inside and outside the company, and acquire the dynamic capability they need to generate new knowledge. Likewise, Soh and Roberts (2003) investigated how networks of innovators affect the development of emerging innovations. They carried out a longitudinal study and studied 150 firms and 319 alliances agreement in the US data communications industry from 1985 to 1996. They used the social network method by using a graphical software program to explore the change and stability of network structures over the period of study. They found that during eras of incremental change in complex technologies, if established firms with peripheral subsystems are able to adopt early new technologies that have implications for compatibility, they may become more central in the technology collaboration network. Furthermore, they concluded that during eras of incremental change in complex technologies, if established firms with core subsystems are able to adopt early new technologies that have implications for compatibility, they may reinforce their central positions in the technology collaboration network.

Ceci and Lubatti (2012) investigated how different types of relationships existing in a network of SMEs influences the development of economic activities and whether personal relationships play a role in supporting innovative activities. They used secondary data and content analysis of 25 semi-structure interviews in 14 firms which

formed a consortium in Automobile industry of Italy to test their model of relationship among different types of relationship (Personal and professional) within a network and various activities (Innovative, Strategic, Operational). They found that innovation in the automotive sector is driven by clients and is developed in collaboration with them. Furthermore, their result of their analysis showed that Strategic activities are enabled mostly by consortium-related associations and personal aspect of relationships with clients increases their innovative potential. Their study also showed that strategic and innovative activities take place in different networks so; the locus of innovation is not the locus of strategy.

2. Management of Networks

Management deals with effectiveness of administrative activities within a network. This area of research explores the role of different governance mechanism in relationship among firms in a network. The legal contracting, opportunism and self-interest are among institutional mechanisms that govern the firms' links in process of innovation. Level of formalization is another factor that determines the nature of a firm tie to other participating firms in network. This is a critical skill that firms should be good at to maximize their participation advantage in network. The project management abilities and leadership competencies are among the highlighted issues that can help firms benefit from participating in innovation networks. Enhancing learning capacity is another important function of network management. Defining mechanism to accumulate, validate and interpreting the knowledge which has been created or absorbed in the process of network collaboration is a very critical skill. Ojasalo (2008) identified several aspects of management of innovation networks: duration of the network; rewards from the network; fundamental meaning of the network; the nature of the networked organization; planning, control, and trust; and hierarchies, authority, and coordination. He stressed these aspects are powerful in mapping and explaining the characteristics of innovation network management.

Reuver and Bouwman (2011) studied the evolution of trust, power and contract as the mechanisms that govern activities inter-organizational value networks and related these mechanisms to different stages of service innovation, namely development, implementation and commercialization. They performed an international survey among operators, content providers and application developers in the Mobile Internet services domain by an online questionnaire and finally received 96 valid questionnaires from main mobile service providers. Their conceptual phasing model relates R&D / Development, Implementation / Roll-out, and Commercial / Market phases as components of service innovation to Authority-based Governance, Contracts-based Governance and Trust-based Governance as components of governance phase. The measures of service innovation phase includes the extent to which Deciding on service concept, Deciding which partners to involve, Preparing launch of beta version of service, Small-scale roll-out of service, Offering commercial version of service to mass market and Extending the basic service offering with additional services, is carried out for the service offering. To measure the governance mechanisms, measures like comparative power of other organizations, the level of influence of other organization, flexibility and responsiveness among organizations in informal situations, use of communication and cooperation for problem solving rather than referring to formal contracts is used. Using Structural Regression modeling, they found that power-based governance is in use in the early stages of developing service concepts and technologies, while trust-based governance is in use during implementation, roll-out and

commercialization. Contract-based governance is most common during implementation and roll-out.

Gardet and Mothe (2012) identified the coordination systems used by SME hub firms that are in a situation of dependence with respect to other members of their network, taking into account the influence of hub firm size. They carried out seven case studies including six innovation networks in which SMEs play a central role and compared them with a “reference” case, in which the hub firm was a large company. Their qualitative analysis found that (1) the sharing of benefits and the guarantees that are implemented vary depending on the hub firm’s degree of dependence, (2) trust and recourse to formal agreements differ according to hub firm size, and (3) conflict solving is influenced by both hub firm size and degree of dependence.

Ojasalo (2008) studied the management of innovation networks by considering two companies operating in the software business and developing their products in inter-organizational networks with very different and contrasting approach in management of innovation networks. He found several aspects of management of innovation networks which can be used to explain the characteristics of these kinds of networks. They are duration of the network; rewards from the network; fundamental meaning of the network; the nature of the networked organization; planning, control, and trust; and hierarchies, authority, and coordination. Based on these characteristics, he concluded that the degree to which companies are oriented towards controlled and structured management in inter-organizational innovation networks may vary significantly. One company may prefer very free management approach while another applies controlled and structured one.

3. Structure and Content of Networks

Structure of a network is defined as the patterns of direct and indirect relationships between actors. Relative position of a firm in the network has a significant effect its access to the information. Powell et al. (1996) developed a network approach to organizational learning and derived firm-level, longitudinal hypotheses that link research and development alliances and experience with network position, managing interfirm relationships, rates of growth, and portfolios of collaborative activities and tested their hypotheses in by carrying out a survey on 225 independently owned companies in biotechnology industry in the period of 1990-1994. They found that networks of collaboration provide entry to a field in which the relevant knowledge is widely distributed and not easily produced inside the boundaries of a firm or obtained through market transactions.

Some of the measures of network structure are network size and number of structural holes and centrality. The most objective measure is network size. Network size and structural holes are important issues which have been included in analysis in many researches. Obstfeld (2005) investigated the micro processes in the social networks of those involved in organizational innovation and their strategic behavioral orientation toward connecting people in their social network. He used the concept of *tertiusiungens* (or “third who joins”) strategic orientation and contrasted it with the *tertiusgaudens* orientation emphasized in structural holes theory which concerns the advantage of a broker who can play people off against one another for his or her own benefit. He argued that as individual's *tertiusiungens* orientation increases he or she involves more in innovation and the fewer the number of structural holes (i.e., the higher the density) in an individual's social network, the greater his or her involvement in innovation. He also argued that one's technical knowledge in a functional area of expertise and his or her social knowledge across all relevant function increases involvement in innovation.

He verified his arguments by a multi method study of networks and innovation in an engineering division of an automotive manufacturer.

Thorgren et al. (2009) used longitudinal data from a sample of 53 networks in Sweden and developed a latent growth curve model to examine the influence of the number of member firms, the extent to which a network is based on firm incentives, and the extent of governance on a network's innovative performance. They developed 5 hypotheses to test direct and indirect effects in their model and finally found that larger networks and bottom-up formed networks achieve greater innovative performance, and that the administrative function partially mediates these effects. To identify the dependent variable (innovative performance), they measured the extent to which the innovative projects in the network have assisted the firms in improving their competitive position, reducing their costs, improving products or services, developing new products, and improving R&D effectiveness.

Salman and Saives (2005) developed a theoretical framework based on social network and innovation management to examine benefits from indirect linkages along with those of direct alliances. They carried out 40 face-to face semi-oriented interviews with biotech firms from the nutrition sector in Quebec, Canada to collect data on partnerships and collaboration, intellectual property, strategy, number of patents and licenses, strategic direction, R&D capabilities and projects, and demographic variables. They used this data and social network analysis to test two theoretical arguments. First, they proposed that a firm's centrality within a network of indirect ties is positively related to the likelihood of it gaining access to complementary knowledge as a result of its alliances. Second, they argued that centrality of a firm's network position within an indirect network is positively related to its innovation.

Wincent et al. (2009) studied network board continuity and effectiveness of open innovation in strategic small-firm networks in Sweden. They argued that there is a U-shaped relationship between board continuity and improvements in network innovative performance and network size moderates this relationship such that the relationship is stronger in larger networks but weaker in smaller networks. They used a sample of 53 small-firm networks which included data for five years (265 data points) to verify their arguments. Their studies showed that under certain circumstances renewal rates among network board officers may be important determinants of improvements in innovative performance of network member firms.

Organizations take benefits of their networks in several ways. Some organizations use inter-organizational networks for transfer of best practices, some gain access to network capital, some use networks for collaborative R&D programs and some use networks to form strategic partners. Unfortunately none of the researches has analyzed the impact of different contents of networks on innovation compare to each other.

4. Formation and Configuration of Networks

This research stream mainly deals with the reasons of firm to participate in networks, the nature of relationship among firms and the position of firms in network. One major focus here is types of resources that a firm gain access to by incorporating in networks to enhance its innovative performance. Another major issue is access to ideas and knowledge base of other firms that can be utilized in process of innovation. Trust is an important mechanism which has been highlighted in a number of researches as a mean for developing and sustaining successful innovation activities in terms of creation and diffusion of knowledge. Finally, the nature and quantity of ties among firms have been focus of analysis of some papers.

Coles et al. (2005) examined the development and management of product development networks in the defense industry and focused on network building processes in terms of the interactions between the individuals involved. They employed case study method to observe two firms working in the defense industry which have been collaborating since 1985 over the development of receiver technology that forms part of military communications systems. They found that conflict and co-operation can co-exist within a complex, dynamic network and the formation of inter-firm product development networks is linked to both internal factors such as strategic decision making, in-house expertise and knowledge management and external factors. The results of their study also showed that both formal and informal networking processes are part of the social factors shaping the development of the technology. They found that while the formal links have defined the division of technical responsibilities, the informal links have influenced the access to information about the progress of the project, knowledge sharing processes and ultimately the ability of both parties to carry out their share of the development.

Ritter and Gemunden (2003) studied the formation and use of technology-oriented interorganizational relationships between firms as a means of gaining competitive advantage. They argued that a company-specific competency is needed to handle, use, and exploit interorganizational relationships. To investigate this network competence they selected a sample of 308 German companies, operating in the fields of mechanical and electrical engineering, measurement technology and control engineering and conducted structured interview with the informants in each firm. Results of their data analysis showed that qualifications and task execution in form of access to resources, network orientation of human resource management, integration of communication structure and openness of corporate culture have a significant impact on degree of network competence and network competence and degree of technological interweavement have significant impact on degree of innovation success.

Dewick and Miozzo (2004) studied the participation of several firms and organizations in the form of inter-organizational relations in the process of innovation by assessing how sustainable technologies in the Scottish social housing sector are introduced and diffused. By performing detailed interviews, they explained that why despite the National Housing Agency policy initiatives to encourage sustainable technologies and processes, a number of factors related to the organizational structure of the construction industry militate against the achievement of this objective. They conclude specifically that relations between contractors and housing associations were marred by conflicting profit and non-profit motives. However, alternative procurement forms that encouraged earlier involvement of contractors were considered advantageous for enhanced performance and innovation by housing associations and contractors. This is in contrast to the views of representatives from the design teams (architects and consulting engineers), which added an element of conflict due to their favoring traditional procurement as a better condition for innovation.

Fitcher (2009) introduced the concept of innovation communities based on promoter theory, which it defines as 'networks of promoters'. He selected 3 cases in high-tech industries to explore the role of promoters and networks of promoters in Open Innovation. He proposed a three level framework for innovation communities which consist of framing and linking level, value chain level and Company level and argued that innovation community functions between two latter levels. The results of his studies showed that transformational leaders as promoters, and especially their close and informal co-operation across functional and organizational boundaries, play a key role in Open Innovation.

Hanna and Walsh (2002) questioned whether cooperation among small firms in areas of marketing, purchasing, R&D and training leads to innovation. To answer this question they studied published evaluation of small firms in Italy, Denmark and USA. For further investigation, they conducted semi-structure interviews with three network broker who were funded by regional governments and had facilitator role for cooperation of firms. They found that networking among small firms is primarily a competitive response. Evolving to innovation needs a mechanism to enable small firms to develop innovative products and processes. They concluded that need for neutrality in facilitation process by brokers and concentration on trust and developing confidence among network members are important factors in formation of networks on small firms.

Future Directions

The review of literature showed that there are some gaps in relationship between inter-organizational networks and innovation. First of all, the empirical researches are very fragmented and context dependent. They address innovation of networks in a variety of settings and different countries. Also, sample size of these studies a major concern that prevents drawing general conclusion. One possible approach to deal with this problem would be a meta-analysis to synthesize empirical researches and eliminating sample size bias. It would be helpful to consider some national level and industry level variables in this meta-analysis as moderating variables to improve exploratory power of research framework.

Second, the focus of most of studies in area of networks and innovation has been on product innovation. This approach may be due to difficulties in measuring other forms of innovation such as process or organizational innovation. However, many benefits of collaboration networks between firms lead to learning potential in organizational practices and processes. Furthermore, accounting for these kinds of innovation creates an opportunity to compare various configurations of networks that leads to different kinds of innovation.

Third, since the studies are spread across different industry and national settings, considering macro level and institutional factors such as governmental policy regarding formation and managing inter-organizational networks and structure of economy seems necessary. This issue specially matters in cross country analysis, because comparing networks activities in different countries without considering macro factors threatens internal validity of researches.

Finally, another promising area of research is considering roles of social and informal activities within networks in line with other formal activities that lead to innovation. A considerable amount of tacit knowledge is exchanged in network relations that have significant contribution to innovation, so research effort is needed to explain the types of these informal activities and mechanisms through which these activities influence network innovative performance.

Conclusion

Despite the vast body of literature in studying the effect of inter-organizational networks on innovative performance of the firms, the lack of a unified framework for integrating different aspects and features of inter-organizational networks and mechanisms through which innovation is affected, is evident. There is an ongoing discussion about whether the research on inter-organizational networks constitutes a theory rather than merely an analytical tool (Bergenholtz & Waldstrøm, 2011). The field of inter-organizational networks seems to be in need of further development and coherence, if it is to be characterized as a theory. This article has provided a

comprehensive overview of empirical studies carried out on the effect of inter-organizational network on firms' innovation. As a result a framework for categorization of investigated papers is proposed. This framework has three dimensions: 1. formation and configuration which mainly deals with the reasons of firm to participate in networks, the nature of relationship among firms and the position of firms in network, 2. Governance which deals with the role of different governance mechanism in relationship among firms in a network, 3. Management which deals with effectiveness of administrative activities within a network. The review of literature showed that there are some gaps in the subject. The focus of most of studies in area of networks and innovation has been on product innovation. However, many benefits of collaboration networks between firms lead to learning potential in organizational practices and processes. Furthermore, the studies are spread across different industry and national settings but have not considered macro level and institutional factors such as governmental policy regarding formation and managing networks. Also most of the studies have not considered roles of social and informal activities within networks in line with other formal activities that lead to innovation. Another shortcoming in the literature is that the empirical researches are very fragmented and context dependent. They address innovation of networks in a variety of settings and different countries. Also, sample size of these studies a major concern that prevents drawing general conclusion. One possible approach to deal with this problem would be a meta-analysis to synthesize empirical researches and eliminating sample size bias. To conclude if innovation performance is to be explained as Bergenholtz and Waldstrøm (2011) say, an analytical approach that involves longitudinal, multiplex data and a whole network conceptualization that includes overall network structures are required and for as a minimum.

Although this review has focused on theoretical and empirical issues relevant to network researchers, there are important practical considerations as well. From the above, it can be concluded that managers should, when considering some sort of alliance with other organizations, take into account all three dimensions of networks specified in this article. Not considering some aspect of networks makes it difficult to harvest the potential gains of such a network.

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