

Research on Knowledge Group of Enterprise Innovation Performance from the Perspective of Social Network

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Abstract. Based on Chinese and other countries papers related to enterprise innovation performance and social network as samples, this paper draws the frontier knowledge map of enterprise innovation performance research from the perspective of social network. From the perspective of social network with different dimensions, the research topics are roughly divided into three knowledge groups, namely, "network structure characteristics and enterprise innovation performance", "internal network capabilities and enterprise innovation performance" Efficiency "and" network location attribute and enterprise innovation performance ". Through the analysis of the content of the cited documents, the frequency of key words and the content of the cited documents, the research context and research progress under this topic are clarified.

Keywords: Social network; enterprise innovation performance; knowledge map; knowledge group.

1. Introduction

If enterprises want to stand firm in this increasingly complex environment, they need to continuously improve innovation performance, and they need to dig deep into the logic behind it. From the neoclassical economics to the industrial theory and the innovation environment theory, the traditional research on innovation performance generally has several paradigms: the perspective of innovative enterprise organization, the perspective of innovative enterprise culture and the perspective of innovative enterprise system. From product innovation, operation innovation to business model innovation, the research of enterprise innovation performance has already gone beyond the boundary of the enterprise itself and expanded into the whole social economic system. Especially in today's information economy society, there are many channels for enterprises to obtain information, but the communication between enterprises and other organizations has become more and more close. On the one hand, the cooperation between enterprises can cross regional restrictions; on the other hand, the selection of information channels has become particularly important. These close connections form a dynamic network system among enterprises, which is connected by division of labor and cooperation between enterprises and other organizations. Enterprises embedded in social networks have both economic and social attributes (Wang Zhongzhi, 2007). Before the formal application of social network analysis to the research of enterprise innovation performance, scholars' research on innovation performance is mainly based on the economic perspective. The main characteristics of this perspective are as follows: first, the research object is usually on the level of binary relationship between the influence of the enterprise itself or the environment on the enterprise, so the deeper research usually focuses on the internal governance and structural evolution. Second, when discussing the causes of formation and other issues, more attention is paid to the enterprise or industry factors at the meso and micro level, and less attention is paid to the macro level (Liu Yi et al., 2003). Therefore, the social network theory and method rise in the social and economic interests, and form a research trend. This paper uses CiteSpace software to search the key words of CNKI database and web of science core database, in order to sort out the research status and development trend in this field more systematically and comprehensively, so as to provide a feasible path for further enterprise innovation research.

2. Research Methods and Data Collection

It is clear that in this study, Chinese data comes from CNKI database, and English data comes from the core collection of web of science. In terms of the determination of the retrieval theme, the Chinese retrieval theme is set as "innovation performance" and "social network", among which the literature time span is 2009-2019. According to scholars' English translation of social network and enterprise innovation performance, the English retrieval theme is set as "social networking" and "innovation performance" or "enterprise innovation performance" as shown in Table 1 below. After the initial search, in order to analyze the accuracy of the results, the selected literature was screened again, and the real-time report of the meeting notice class was deleted. Finally, 1950 Chinese effective literature and 2085 English effective literature were obtained (227 of which are for the innovation performance of enterprises).

Table 1. data collection process

data sources	Retrieval mode	Effective record	Retrieval time
CNKI	Theme = social networks and innovation performance year=2009—2019	1950	2019-12-31
Web of Science	Theme="Social Networking"AND"innovation performance" year=1990—2019	2085	2020-1-8
	Theme="Social Networking"AND"Enterprise innovation performance" year=1999—2019	227	2020-1-8

3. Knowledge Group Map

According to the key annotation of the nodes between clustering and clustering, the main driving forces of relevant research can be combed. Then by analyzing these classic literatures (see Table 2 below), the effective literature clustering of research topics can be summarized into three knowledge groups.

Table 2. mental literature information of high centrality

centrality	Paper	Publication time
0.29	Entrepreneurial orientation and firm performance: the intermediary role of strategic flexibility[4]	2019
	Research on the relationship between innovative strategic human resource management and enterprise performance of high-tech SMEs[5]	2010
	The influence of management innovation and technology innovation matching on enterprise performance[6]	2018
0.22	Research on the relationship among the integration of senior management team behavior, innovation behavior and innovation performance[7]	2012
	The influence of R & D investment on Regional Innovation Performance -- the intermediary effect of R & D investment of enterprises[8]	2016
0.19	The impact of transformation and upgrading and corporate social network on Corporate Performance: a case study of manufacturing enterprises in the Pearl River Delta[9]	2015
	Research on the impact of corporate social responsibility on performance based on technological innovation[10]	2013
	The influence of management innovation and technology innovation matching on enterprise performance [6]	2018

0.13	Research on the relationship between innovative strategic human resource management and enterprise performance of high-tech SMEs[5]	2010
	Research on knowledge transfer and innovation performance among enterprises[11]	2018
0.11	Research on the influence of enterprise relationship capital on technological innovation performance[12]	2018
	Research on the correlation mechanism between technological innovation performance and corporate social capital of small and medium-sized technological enterprises: the regulatory effect of technological innovation performance information disclosure[13]	2010
	The influence of knowledge and cooperation network structure hole on technological innovation performance[14]	2013
0.10	Antecedents of knowledge transfer from consultants to clients in enterprise system implementations[15]	2005
	ERP systems adoption: An exploratory study of the organizational factors and impacts of ERP success[16]	2007
	Innovation diffusion in global contexts: determinants of post-adoption digital transformation of European companies[17]	2006
	Innovation types and performance in growing UKSMEs[18]	2007
0.09	Open innovation in SMEs-An intermediated network model[19]	2010
	Inbound Open Innovation Activities in High-Tech SMEs: The Impact on Innovation Performance[20]	2012
	The export orientation and export performance of high-technology SMEs in emerging markets: The effects of knowledge transfer by returnee entrepreneurs[21]	2009
	Social Media, Knowledge Sharing, and Innovation: Toward a Theory of Communication Visibility[22]	2014
0.08	How do multinational companies leverage technological competencies? Moving from single to interdependent explanations[23]	2004
	Intellectual capital and new product development performance: The mediating role of organizational learning capability[24]	2009
	The Role of Foreign Technology and Indigenous Innovation in the Emerging Economies: Technological Change and Catching-up[25]	2011
	The impact on innovation performance of different sources of knowledge: Evidence from the UK Community Innovation Survey[26]	2009
	Exploring the complementarity between innovation and export for SMEs' growth[27]	2011
0.07	Information systems innovation for environmental sustainability[28]	2010
	Inbound Open Innovation Activities in High-Tech SMEs: The Impact on Innovation Performance[29]	2012
	Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance[30]	2007
	Market orientation, innovativeness, product innovation, and performance in small firms[31]	2004
	Managing foreign R&D laboratories in China[32]	2004

It should be pointed out that from the perspective of the literature content with high centrality and frequency, analysts from the perspective of social network pay attention to the following factors, as shown in Figure 1, including the characteristics of the network structure, such as: the scale, density, concentration, structural hole, isolated point, equivalence, stability, etc., which affect the innovation performance of enterprises; the unstructured capabilities at all levels of the network Power, such as: the impact of various innovation capabilities, resource integration capabilities,

members' social status, social capital, etc.; as well as the impact of network location attributes, such as knowledge management feedback process, the market environment of the network, the dominant form of the network, etc.

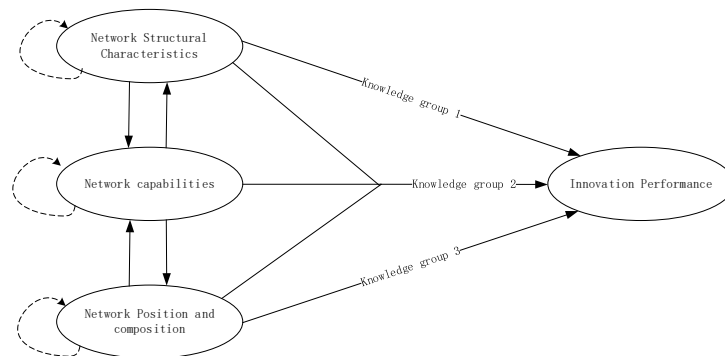


Figure 1. main problem model under this theme

3.1 Knowledge Group 1: Network Characteristics and Enterprise Innovation Performance

From the perspective of social network theory, the history of enterprise innovation research is not very long, and the research results are very rich. From the perspective of knowledge map, the research theme has experienced the development from local analysis to the overall network. From the perspective of local network, the key node literature of knowledge group 1 emphasizes the form of social network around the enterprise itself, focusing on the network characteristics to analyze the degree of binary interaction between the subjects (jenssen, 2001; sigh, 1999; Nooteboom, 2004). Scholars believe that the organization of network can achieve the full coordination of resources and technology, thus playing the role of factor allocation. The relationship between the allocation of factors and the innovation performance of enterprises has been studied by many scholars through various angles, and the characteristics of enterprise network structure are divided. The network structure can be divided into connection strength, network breadth, network scale and other dimensions (Liu Lanjian, 2011; Zhang Xiue, 2012; Dong Baobao, 2014; Huang Yan, 2016; sasidharan s et al, 2017 And so on). Under the theoretical framework of "network knowledge acquisition innovation performance" (Xie Yongping, 2016; ye Yingping, 2017), the social network characteristics, an important influencing factor of enterprise innovation performance, are described, and some conceptual models are established. Enterprise and entity nodes show a variety of network characteristics, which determine the knowledge innovation ability of enterprises (MAH, 2018), and then affect the innovation performance of enterprises.

Table 3. Knowledge group 1 core author's point of view

Author	Point of view
Assis(2003)	In the process of network members grinding and absorbing each other, innovative achievements are formed.
Rosenkopf & Almeida (2003)	Strong connection with network partners helps to expand vision and facilitate innovation.
Laursen & Salter(2006)	The relationship between network connection breadth and innovation performance is inverted U-shaped.
Cowan(2007)	In the process of network formation, the choice of other network members is based on the complementarity of knowledge, skills and other resources.
Lavie (2007)	Heterogeneous performance of network members promotes enterprise innovation.
Tiwana (2008)	Strong connection promotes knowledge integration and enterprise innovation.
Eisingerich, Bell & Tracey (2010)	The intensity of practice among network members improves the innovation performance of clusters.
Wei Jiang et al.(2014)	The network characteristics of focus enterprises will have a positive impact on their product innovation performance. [33]
Zeng Deming et al.(2014)	Network strength and enterprise innovation have a significant positive impact.[34]

Table 4. Frequency of key words in literature cited by Chinese related research in group 1

Keyword	Frequency
Social network	38
Innovation performance	16
knowledge acquisition	3
human capital	2
Heterogeneity	2

Through the interpretation of the core author's point of view (see Table 3) and key nodes cited literature key words (see Table 4), the content and characteristics of knowledge group 1 can be summarized as follows: Starting from the characteristics of the network, the factors that affect the characteristics of the network and the dimensions of the characteristics of the network are disassembled, and the qualitative and quantitative methods are used to evaluate the impact on innovation performance, so as to provide theoretical reference for improving the innovation performance of enterprises.

3.2 Knowledge Group 2: Network Capability and Enterprise Innovation Performance

According to the key node literature of knowledge group 2, the network capability of an enterprise has a significant positive impact on the technological innovation capability of an enterprise (Ritter and gemunden, 2003), and participates in the development and innovation process of other enterprises through network connection. On this basis, many scholars in China have expanded. Ma Gang et al. (2005), Cao Peng (2009), Chen Xueguang (2010), Ren Shenggang (2010) and other scholars have successfully verified the conclusion that enterprise network capability has a significant positive impact on innovation performance. Scholars use different dimensions to measure the network capability, and prove that knowledge resources have a positive correlation effect on the network capability of enterprises (viol J, 2016; Song Jing, 2016). Further exploration of network capability shows that dynamic capability is an important tool for enterprises to improve innovation performance. Through dynamic capabilities to emulate core strengths, and re allocate resources to build, and then improve innovation performance (Griffith and Harvey, 2001), it has been empirically tested by many scholars. Borch and Madsen (2007), Zhou Rongxin (2012), Ma Chaochao (2013), Xu Zhaohong (2014), Wu Hang (2016), etc. have paid attention to and demonstrated the research on technological innovation performance.

Table 5. Knowledge group 2 core author's point of view

Author	Point of view
Ritter et al. (2003)	Network capability can reduce the obstacles in the process of network node communication to a certain extent, and fully obtain the benefits of cooperative relationship.
Verona and Ravasi (2003)	Dynamic capability enables enterprises to innovate continuously through knowledge creation, integration and reconstruction.
Chen and jaw (2009)	Dynamic capability has the advantage resource capability which is difficult to be imitated, and it is the important foundation of the company's continuous innovation.
Chen Xueguang et al. (2010)	Three adjusting variables are introduced to verify the importance of network capability to the innovation and development of enterprises.[35]
Cai Shutang (2011)	Environmental adaptation, learning absorption and innovation capability are different dimensions of dynamic capabilities, which jointly promote the sustainable growth of enterprises.[36]
Duan Haiyan (2012)	As an important performance of corporate social capital, chain directors help to improve the innovation performance of enterprises and reduce organizational redundancy.[37]
Wu Junjie et al. (2015)	There is an inverted "U" relationship between the extensiveness, relationship strength and innovation performance of the entrepreneur social network[38]
Wang Yuxiao (2018)	This paper discusses the direct effect of network capability on investment performance from two dimensions of network resource perception first mover capability and allocation and utilization capability.[39]

Table 6. Frequency of key words in literature cited by Chinese related research in group 2

Keyword	Frequency
Social network	19
Innovation performance	8
Enterprise performance	3
Dynamic capability	2
Knowledge intensive service enterprises	2

Through the interpretation of the core author's opinions (see Table 5) and key points cited in the literature (see Table 6), the content and characteristics of knowledge group 2 can be summarized as follows: Scholars use different dimensions to measure the network capability. Through the intermediate variables and regulatory variables, they investigate the path and mechanism of the network capability on innovation performance, which increases the application value and guiding significance of the theory of enterprise network capability in practice.

3.3 Knowledge Group 3: Network Position and Enterprise Innovation Performance

The improvement of innovation performance is the result of interaction between producers and customers, so it is affected by geographical proximity, cultural interoperability, language commonality, etc. (Almeida, 1999; Capello, 1999; DARR, 2000; asheim, 2002; Scott, 2002; whlttington, 2009). Excessive geographical proximity will lock in the network knowledge, thus lacking the potential to create new knowledge, rather than the positive effect of local connections on Innovation (DARR, 2000; asheim, 2002; Scott, 2002). The basis of innovation performance lies in the acquisition of innovation resources, and different positions of enterprises in the network will lead to different internalization process of enterprise resources (Chen Di, 2006; Qian Xihong, etc., 2010, etc.). Network centrality has a positive impact on the performance of knowledge innovation (Zhang Hua and Lang Chungang, 2013; Wang Dan, 2016; Zheng Jiankang, ye Zheng, Xu Yinjie, 2017). In terms of network embeddedness, it is necessary to break through regional network restrictions and achieve a new round of innovation and upgrading.

Table 7. Knowledge group 3 core author's point of view

Author	Point of view
Boschma & Ter Wal (2007)	Centrality is positively related to innovation performance.
Chen Zhiguo (2016)	The embeddedness of enterprise network needs to break through the limitation of the regional network and realize a new round of innovation and upgrading [40]
Liu Shanshi, Sun Bo, Ge Chunmian, Wang Qi (2017)	The centrality of the network will further strengthen the openness of enterprises and make the openness of cluster enterprises have an impact on innovation performance.[41]
Zheng Jiankang, ye Zheng, Xu Yinjie (2017)	The centrality of the network will further strengthen the openness of enterprises and make the openness of cluster enterprises have an impact on innovation performance. [42]
Rubino M, Vitolla F(2018)	The geographical openness of network is negatively related to the performance of enterprises.
Cinelli M, Ferraro G(2019)	Abstract collaborative innovation network focuses on promoting members' interaction and cooperation ability, to improve opportunities for innovation promotion.

Table 8. Frequency of key words in the literature cited by Chinese related research in group 3

Keyword	Frequency
Network relationship	19
Centrality	11
Network members	11
Performance impact	10
Enterprise cooperation	8
Organizational learning	8

The review of the research results of knowledge group 3 at home and abroad shows that scholars have used different methods to build a solid theoretical foundation for the relationship between network location, knowledge acquisition, cooperation between enterprises and innovation performance. In particular, the central and embedded aspects provide demonstration methods and ideas.

4. Conclusion

Based on the text data of CNKI (2009-2019) and web of Science Database (1999-2019), this paper draws a knowledge map. Through in-depth mining of map information and in-depth reading of literature, it compares the research hotspots at home and abroad, and summarizes three knowledge groups. The main conclusions and implications are as follows:

Firstly, the research on related topics in the world originates from the exploration of the interaction between enterprise innovation and its surrounding environment. It is found that the characteristics and attributes of social networks can affect the improvement of innovation performance through knowledge acquisition. Around how to improve the innovation performance of enterprises, scholars explore the different dimensions of a social network and strive to clarify the formation mechanism of enterprise innovation performance improvement.

Secondly, China is an important force in international research on this topic, with the number of research results ranking first. Besides, the United States, Britain, Italy and other countries are also the main research force in this field. China's research is generally based on China's national conditions. From the perspective of social networks, innovation performance research is a very consistent point of entry with the characteristics of Chinese culture. Therefore, the number of research results is relatively large, and the research topics involve a wide range of fields, with the same degree of focus and frequency.

Thirdly, there are still many problems to be discussed in the research on this topic. Although the perspective of social network research has been paid attention to, the research of network characteristics focuses on the micro-level, while the research of micro level and macro level pays little attention, especially the micro-level characteristics and how to measure the existing mechanism and empirical test are worthy of further discussion. The innovation performance of many enterprises in our country shows a sudden improvement. The new progress of practice requires the renewal of theory and the empirical test of common and individual characteristics, which requires more new ideas, such as the mechanism and test of network interaction.

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