A Summary of The Research on The Influence of Network Innovation on Enterprise Innovation Performance

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Abstract: The external environment of enterprises is becoming more and more complex, and innovation by means of network cooperation has become a common mode of global enterprise organization development, so enterprise innovation network has become one of the research hotspots. Uncertainty and change also bring opportunities and challenges to the development of enterprises. Innovation has evolved into a process of collaboration and cooperation, and it is also a process in which enterprises form innovation networks through continuous cooperation. In this study, the research on the direction of enterprise innovation network is sorted out and summarized by sorting out the related literature on the structure of innovation network and the internal mechanism of innovation network, and the future development direction of enterprise innovation network research is discussed.

1. Introduction

Nowadays, the ever-changing market environment and technical environment have become important factors threatening enterprise innovation. Only relying on the internal information of enterprises can no longer meet the needs of innovation activities. At this time, it has become a new effective choice to search for knowledge from outside and obtain resources through different channels. Enterprises link with universities, research institutions, governments, capital markets, intermediaries and other main bodies to form cooperative organizations through contracts, agreements, social relations and other ties, and integrate innovation resources inside and outside the organization. The cooperative innovation based on network integration has quickly become one of the modes commonly adopted by global enterprises [1]. In many stages of innovation network evolution, there are some differences in different network evolution paths, and the industry, technology, system, economy and cultural background in which enterprises are located will all influence the network evolution paths [2]. Therefore, it is necessary to study the influence of enterprise innovation network on innovation performance, so as to further develop relevant theories and open the internal influence mechanism.

2. Related concepts of innovation network

Social network theory explains the behavior of individuals in the network and the systematic behavior as a whole, and it also becomes the theoretical basis of innovation network. Based on this theory, Freeman (1991) formally put forward the concept of innovation network: a basic institutional arrangement with the characteristics of informal and implicit relationship, and the main mechanism for the formation of network framework is the innovation cooperation among enterprises [3]. Aken and Weggeman(2000) defined the innovation network as a network organization existing in the process of product innovation from the perspective of the structure of the innovation network. This network organization is a system composed of autonomous and equal enterprises through establishing lasting business contacts [4]. Harris, Coles and Dickson (2000) think that the innovation network refers to a collaborative innovation body formed by innovation participants such as enterprises, R&D institutions and innovation-oriented service providers in formal or informal forms. In the innovation network, all kinds of innovation participants strive to establish mutually beneficial and flexible

relationships, jointly develop new products and realize the commercialization of innovation results, so that the overall innovation capability of the innovation network exceeds the sum of individual innovation capabilities of participants [5]. It can be seen that despite different opinions, scholars' definitions basically emphasize that innovation network is a formal or informal connection.

Under the networked innovation mode, the knowledge elements required for enterprise innovation will inevitably break through the boundaries of a single organization. The innovation network between organizations is an important way for enterprises to obtain information and knowledge from outside, which can help enterprises overcome the constraints of time and resources. The external technical cooperation network of enterprises is conducive to sharing resources among enterprises, integrating technical knowledge and material assets within the network and accelerating the development process of new technologies [6]. On the other hand, in the process of sharing knowledge and information through the network, enterprises build trust and form commitment, which is conducive to integrating technology to speed up the innovation process, thus improving the innovation performance of enterprises.

3. Related theory

3.1 Network embedding theory

The concept of "embedding" was first put forward by Hlavaty in the field of mathematics, and then widely used in the fields of sociology and economics. Granovetter introduced the concept of "embeddedness" to enterprises, pointing out that the communication and cooperation between enterprises is completed in the context of network embeddedness, and the innovative behavior of enterprises is embedded in the whole social network through the way of structure and relationship [7].

The research on the relationship between network embeddedness and innovation performance can be divided into the following two types: first, relationship embeddedness and innovation performance. Relationship embeddedness refers to the role of coordinating the direct association between enterprises as a mechanism in the process of enterprises acquiring resources, which can promote the trust between the main enterprises in the network and other enterprises, so the knowledge, technology and other resources in enterprises can flow freely. Second, structural embeddedness and innovation performance. Structure embeddedness is represented by the density and scale of the embedded network of enterprises and the number and location of "structure holes" occupied by enterprises. Structure embedding can help enterprises identify the potential information of peers and inter-banks, help enterprises to understand the changing trend of the market and update the corresponding policies. The higher the degree of structure embedding, the easier it is for enterprises to obtain heterogeneous resources, thus improving innovation performance.

3.2 Structural hole theory

In the enterprise innovation network, different network locations represent different opportunities to acquire new knowledge, and acquiring new knowledge is one of the key factors for innovation activities [1]. Variables to measure network location include proximity, centrality, structural hole, etc. Related research can be divided into two categories: First, study the proximity between enterprises and network partners in geographical location. By taking advantage of the geographical position of enterprises, we can reduce the phenomenon of knowledge spillovers within the network, enhance the diversity of members within the network and improve the performance of enterprises. The second is to study the mechanism of enterprise centrality and structural hole location in innovation network. Centrality refers to the proximity of enterprises to the core position in the innovation network. High network centrality gives enterprises more network rights, making it easier for enterprises to acquire and control new information related to innovation in the network [8]. The structural hole theory points out that if an enterprise is connected with many unconnected individuals, then this structure will be very beneficial to the enterprise, and the enterprise occupying the position of the structural hole can interact with more enterprises and obtain more information resources and technical resources.

3.3 Weak connection theory

It is generally believed that the trust mechanism generated by "strong relationship" is beneficial for enterprises to acquire external knowledge, thus realizing the sharing of resources and interests and improving the innovation performance of enterprises [9]. On the other hand, some scholars believe that the non-redundancy of "weak relations" is the key source of valuable new knowledge. On the issue of the influence of strong and weak relationship on the innovation orientation of enterprises, scholars generally believe that strong connection is beneficial to progressive innovation, while weak connection will promote breakthrough innovation [10]. Therefore, whether enterprises choose to build "strong connection" or "weak connection" is still a problem that needs practical consideration, and there is no definite answer. With the evolution of network relationship research, network relationship has gradually developed into a comprehensive concept including relationship strength, relationship density, clustering, heterogeneity, diversification and other dimensions, which shows that the mechanism of network relationship on enterprise innovation performance is still the key research direction.

3.4 Life cycle theory

This theory has been widely used to study the economic activities and technological innovation of enterprises. The activities and density of entrepreneurs in building social networks will be different with different development stages of enterprises. With the evolution of the product life cycle stage, the technological innovation ability and the key work of innovation of enterprises will change accordingly. The social capital accumulated by embedding social network connection strength, social network scale and trust and reciprocity in different life cycles may affect the innovation performance of enterprises in different life cycles.

4. Antecedent variable

According to the strong relationship theory, strong relationship can help enterprises to establish a strong cooperative relationship of trust and respect with external institutions, thus helping enterprises to acquire key knowledge and technology and improve innovation performance; According to the weak relationship theory, weak relationship can also help enterprises gain more resource heterogeneity, promote diversified development of enterprise knowledge and improve innovation performance of enterprises [11].

The dual functions of ecological embeddedness and political network embeddedness will affect the innovation performance of enterprises. Embedded in the innovation ecosystem, enterprises can better understand the development direction of technology, make it easier for enterprises to acquire and coordinate complementary technologies, and quickly adjust innovation strategies. At the same time, it can also help the healthy development of innovation ecosystem. Embedding the enterprise into the political network can bring high legitimacy to the enterprise, enabling it to obtain resources from other organizations, thus obtaining the support of venture capital and alleviating the financing pressure. However, enterprises embedding innovation ecology and political network at the same time may lead to redundant resources and require enterprises to pay more coordination costs [12].

Based on the structural hole theory, the research proves that the lower network density of enterprises can also promote innovation performance [6]. At the same time, the structural hole characteristics of organizational cooperation network and knowledge fusion network have a significant positive impact on organizational innovation performance [13]. Having significant structural holes indicates that organizations have greater network power in cooperative networks, which is conducive to forming control advantages and obtaining diversified information resources, thus improving organizational innovation performance; For the knowledge fusion network, the remarkable feature of structural holes means that there are a large number of unconnected knowledge elements in the knowledge fusion network, and it also means that the knowledge search behavior in the network is less constrained, which is conducive to the organization to carry out innovative activities. The pairwise interaction terms of organizational cooperation network, member cooperation network and knowledge fusion network

structure hole feature have significant positive influence on organizational innovation performance, and the interaction between member cooperation network and knowledge fusion network has the greatest influence on organizational innovation performance [14].

Formal cooperation networks and informal cooperation networks are also one of the important antecedents for studying innovation performance. Formal cooperation network refers to the long-term and stable cooperative relationship established between enterprises and external organizations through formal agreements, contracts and systems. Small and medium-sized enterprises establish formal cooperation networks with external organizations through formal contracts, which can effectively guarantee the smooth development of cooperation, promote the interaction and flow of knowledge, technology and resources among various organizations for a long time and stably, enable enterprises to obtain resources and technologies that they do not have or complement each other, and make up for the limitation of insufficient innovation resources of small and medium-sized enterprises [15]. Informal cooperation network refers to the cooperative relationship established by enterprises and other organizations through non-contractual means, which enables enterprise personnel to have more opportunities to communicate privately with partners, promote the transfer of tacit knowledge, and then improve innovation performance [15].

The existing research results show that, in the initial stage, extensive social network scale and good trust and mutual benefit relationship promote the innovation performance of cultural cluster enterprises; In the growth period, the intensity of enterprises' embedding in social networks and good trust and reciprocity promote the innovation performance of cultural cluster enterprises, while the scale of extensive social networks negatively affects the innovation performance of cultural cluster enterprises. In the mature stage, extensive social network scale and good trust and mutual benefit will promote the innovation performance of cultural cluster enterprises [16]. This may be because the social network relationship between enterprises based on trust relationship is conducive to knowledge sharing, information flow, and mutual learning among organizations. At the same time, it is also conducive to entrepreneurs accumulating social capital through social relationships and promoting technological innovation activities of enterprises.

5. Intermediary mechanism

Hui Zhang et al (2021) explained the role between network embeddedness and innovation performance from the perspective of dynamic capabilities. Internal dynamic capabilities of enterprises include resource integration capabilities, learning capabilities and innovation capabilities. This study puts forward four path combinations of enterprise innovation performance improvement, namely, network embedding-capability promotion type, dual capability promotion type, network embedding-capability conflict type and innovation capability deficiency compensation type [17].

Zhaoyuan Yu et al (2020) studied the relationship between social network and innovation performance with knowledge management capability as the intermediary variable, and the research conclusions are as follows. First, social networks within enterprises will positively influence innovation performance through the chain transmission of knowledge creation, knowledge transformation and knowledge innovation capability in turn. Secondly, the external social network of enterprises positively influences innovation performance through the chain transmission of knowledge absorption, knowledge connection and knowledge desorption capability in turn. Thirdly, specifically, the interaction items of internal and external social networks of enterprises can have a positive impact on innovation performance through the double chain transmission of knowledge creation-knowledge transformation-knowledge innovation capability and knowledge absorption-knowledge connection-knowledge desorption capability [18].

Zhoutao Cao et al (2020) studied the mediating effect of two kinds of failure learning on the relationship between multiple network embeddedness and team innovation performance. Specifically, using failure learning mediates the embeddedness of internal knowledge network and team innovation performance, and mediates the inverted U-shaped relationship between embeddedness of external knowledge network and team innovation performance. Exploratory failure learning plays a significant

mediating role in the inverted U-shaped relationship between knowledge network embeddedness and team innovation performance in two dimensions [19]. The embeddedness of two dimensions of knowledge network plays an indirect role in team innovation performance through utilization failure learning and exploratory failure learning in turn, and utilization failure learning and exploratory failure learning play a chain intermediary role in it.

Simeng Liu et al (2019) studied the interaction among network embeddedness, knowledge integration and innovation performance. Knowledge integration refers to a knowledge aggregation that enterprises rebuild in the process of R&D in order to integrate and develop knowledge. The results show that structural embeddedness in network embeddedness has a significant impact on knowledge acquisition and knowledge reconstruction in knowledge integration, relational embeddedness in network embeddedness has a significant impact on knowledge acquisition, knowledge integration and knowledge reconstruction, structural embeddedness has a significant impact on innovation performance, and knowledge acquisition in knowledge integration has a significant impact on innovation performance [20].

6. Regulated variable

High-tech enterprises have a negative moderating effect on the relationship between strong linkage and entrepreneurial performance, and a positive moderating effect on the relationship between network scale and entrepreneurial performance. Transition countries have a positive moderating effect on the relationship between network structure and entrepreneurial performance [21]. It can be seen that the network mechanism is dynamic and contingency, which is jointly influenced by the development stage, life cycle and regional institutional environment of enterprises. New enterprises are faced with new entry barriers, legitimacy, resource shortage and other problems, and the demand for network resources is more vigorous. High-tech enterprises need to solve the problem of uncertainty, so they need weak connection and larger network scale to provide heterogeneous information. The more interaction between the system and economic activities, the less standardized the market and the more prominent the role of network activities.

Internal knowledge heterogeneity refers to the degree of diversification of internal technical knowledge, which is mainly reflected in the diversity of employees' knowledge and technology, professional background and ideas, and the diversity of technical knowledge and technology development fields owned by the enterprise itself. According to the existing research, knowledge heterogeneity within enterprises has a positive moderating effect on the relationship between formal and informal cooperation networks and innovation performance of SMEs [15].

It is proved that market legitimacy positively regulates the relationship between relational embeddedness and innovation performance, and political legitimacy positively regulates the relationship between structural embeddedness and innovation performance [7]. High market legitimacy means that enterprises must abide by market norms and restrict their opportunistic behaviors in the course of business operation, so as to establish sustained and stable cooperative relations with business partners and jointly improve innovation performance; High political legitimacy requires enterprises to maintain a high centrality in their interactions with the government, adhere to the industry standards and norms formulated by the government, and accomplish the relevant goals set by the government, so as to get the support and recognition of the government and obtain policy assistance, so as to improve the innovation performance.

7. Summary and prospect

The research results show that the research of enterprise innovation network is developing rapidly, and the related research topics are intertwined with some new forms of innovation, which makes the research boundary constantly expanding. At the same time, the research of innovation network also shows strong commonality, which has research value in many research directions such as innovation,

entrepreneurship, organization and strategy, and can provide novel research ideas from the network perspective.

It is the inevitable outcome of the development of the times for enterprises to innovate in the way of network cooperation, which has distinct characteristics of the times. Therefore, it will inevitably evolve further, so that we can always grasp the changing trend of the times background and clarify the development direction of the innovation network. As a way to help enterprises connect different subjects to obtain innovative resources, the network has rich practical significance and theoretical value. Scholars need to pay more attention to the changing Chinese model of enterprise innovation network practice, explore the local problems of Chinese enterprises, and build and improve the theoretical system of enterprise innovation network research with Chinese characteristics.

7.1 Seize the opportunity and empower the innovation network.

Whether it is a new platform network or a digital innovation network, it is a new type of innovation network established by large enterprises with core resources by technical means. It has become a major trend for large enterprises to become the leader of enterprise innovation networks. This further highlights the key position of core enterprises in the network, and also creates the situation of "winner takes all" in the Internet era. In this situation, enterprises must seize the opportunity of development, strive to improve their network status, emphasize the role of value co-creation in cooperation, and inject impetus into the innovation network. At the same time, as one of the important means for enterprises to cope with environmental changes, innovation network requires enterprises to keep up with the development rhythm of information technology and the iterative speed of knowledge resources. The dynamic network capability of the enterprise itself is the key factor to deal with this complex situation. Enterprises need to continuously scan the resources and opportunities in the external digital environment in order to enhance their competitiveness and realize the double innovation of enterprise performance and network status.

7.2 Pay attention to governance and give full play to core advantages.

Enterprises always need to cooperate with more and different subjects to obtain more diverse innovation resources, which weakens the intensity and depth of cooperation among different subjects in the original enterprise innovation network and makes the enterprise innovation network looser. In addition, uncertainty makes enterprise innovation networks more vulnerable to impact, and the emergence of problems such as rapid technological changes and technical barriers makes innovation networks based on weak connections more vulnerable. Traditional network governance mainly depends on relationship governance and contract governance, but these two methods are difficult to cope with the ever-developing market environment. Therefore, uncertainty requires enterprises to constantly find new effective governance models. At the same time, as the leading force of entrepreneurial network, core enterprises need to give full play to their own resources and information advantages in network governance to protect the maintenance and development of innovation network.

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