

Innovative Research and Development of Strategic Alliance of Core Technologies in The Emerging Technology Supply Chain

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Abstract: With the coming of the era of knowledge economy, in order to deal with the ambiguity and uncertainty of the environment, the strategic alliance of enterprises has become a new business model. As a knowledge-intensive industry, emerging technology industry is characterized by high technical complexity, high R&D uncertainty, high innovation cost, and long R&D cycle. Therefore, enterprises need to transfer and flow knowledge through strategic alliance, carry out complementary R&D and resource complementing, constantly absorb new knowledge and high-quality resources, and rationally allocate resources. At the same time, in the face of emerging technologies, the core technologies, as the core elements of the production chain of emerging technologies, are often mastered by the core technology suppliers, which requires the effective collaboration of supply chain enterprises, the use of group knowledge to break through the bottleneck of technology research and development and marketization, reduce the uncertainty of research and development, and achieve the strategic goal of mutual benefit and win-win.

Keywords: Emerging technology supply chain, Strategic alliance, Innovative research and development.

1. Cooperative Innovation in Supply Chain Context

1.1. The basic characteristics of supply chain cooperative innovation

In the face of fierce competition, technological innovation has become the basic means for enterprises to participate in market competition [1], which has an important impact on economic growth. Innovation is the source of competitive advantage for enterprises, with high returns, but it has high risk, openness and knowledge complementarity [2]. Technological innovation is a dynamic process that begins with research and development and ends with market realization. In this process, different combinations and configurations of various factors involved constitute different modes of technological innovation [3]. Therefore, a single enterprise needs to cooperate with other enterprises to carry out cooperative innovation through risk responsibility sharing, resource sharing and knowledge complementing mechanism. As for the need for collaborative innovation, Ohmae said, "Today's products rely heavily on many different key technologies, and most companies cannot always remain users of all these advanced technologies..." It is impossible for any enterprise to possess all the advanced knowledge and technology related to its own production and service at the same time [4]. In today's high-quality and networked development, enterprises will be unable to do anything without innovation cooperation [5]. Therefore, under the background of today's world economic pattern, the establishment of cooperative relations between enterprises is the key factor for enterprises to gain competitive advantages. For cooperative innovation, domestic and foreign scholars have made different definitions of its connotation. Cao Xing believes that cooperative innovation is a process in which enterprises and partners learn from each other and gradually realize cooperative management and cooperation mechanism

in the "interweaving" process of all parties [6]. Yin Junjie et al. believe that cooperative innovation is a process in which enterprises and partners jointly research and develop new technologies, new products, new processes and new services based on resource complementarity and innovation risk reduction [7]. Hu Qinfang et al. believe that cooperative innovation is a cooperative behavior in which focus enterprises and suppliers invest their own resources for original new products and services based on common interests and share benefits and risks [8].

With the development of supply chain management ideas, cooperative innovation, as an important innovation mode of technological innovation, has begun to transform from traditional production-university-research cooperation and horizontal cooperation between enterprises into vertical cooperation of supply chain [9]. The traditional business relationship between upstream and downstream enterprises is gradually changing to the establishment of strategic cooperative partnership. With the intensification of market competition, the uncertainty of market demand and the increase of diversity, the competition among horizontal enterprises gradually turned to the competition among supply chains, which also promoted the cooperative research and development between upstream and downstream enterprises in the supply chain, making this new cooperative research and development mode gradually become the mainstream. In recent years, such vertical supply chain collaboration innovation has attracted high attention from researchers. It is found that due to the existence of resource potential difference, the upstream and downstream enterprises in the supply chain can effectively use each other's technological and resource advantages by establishing industrial synergy mechanism through division of labor, cooperation and resource sharing. Efforts should be made to shorten the R&D cycle of new products, reduce production costs, improve product quality and expand market demand [10].

1.2. The driving factors of cooperative innovation in supply chain

D'Aspremont and Banerjee pioneered the cooperative innovation and development of enterprises, established a two-stage model of duopoly R&D game, namely AJ model, and compared and analyzed the R&D level and output level of enterprises under three modes: no technology R&D, independent R&D and cooperative R&D. It is found that cooperative R&D among competitive enterprises in the same industry can increase the level of R&D investment and social welfare [11]. However, when technology spillover is at a high level, horizontal cooperative innovation R&D enterprises will reduce the degree of information sharing and the scale of cooperation [48], and with the increase of the number of cooperative enterprises, the negative impact will be smaller. When the whole industry participates in cooperative innovation R&D, the R&D investment and income of the technological innovation will reach the optimal level [12]. However, this ideal state is difficult to achieve in the real world. It is found that when enterprise cooperation is incomplete, the increase of technology spillover generated by horizontal cooperative innovation R&D activities will have a negative impact on R&D level and social welfare; however, when such spillover is vertical, the increase of vertical technology spillover will have a positive impact on R&D level and social welfare [13]. For cooperative innovation and R&D activities among enterprises, horizontal cooperation has gradually changed into vertical cooperation on supply chain. The research on the independent R&D of upstream enterprises and the cooperative R&D of upstream and downstream enterprises in the supply chain found that, under certain conditions, the cooperative innovation R&D can improve the R&D input of both parties, increase the consumer surplus and maximize the profit, and the optimal R&D cost sharing coefficient was obtained [14].

It is found that the cooperative R&D of upstream and downstream enterprises in the supply chain greatly improves the probability of successful technology R&D, reduces R&D risks and improves the profit level of both parties due to the existence of resource complementarity [15]. As for the low efficiency of the traditional supply chain, suppliers independently develop new products to compete with manufacturers, which stimulates R&D by means of "advertising signals". When the market acceptability of new products is high, suppliers will choose to cooperate with manufacturers for R&D to achieve a win-win situation [16]. In the innovation R&D activities of enterprises, the participation of suppliers and customers can increase the proportion of enterprises choosing the breakthrough innovation mode, and price elastic demand also has an important impact on the choice of innovation mode of enterprises [17].

Through the summary of the existing research, it can be found that collaborative research and development can reduce the risk of technology development. With the rapid development of market demand and market economy, product life cycle is constantly shortened, which requires technology research and development to improve efficiency and reduce costs. However, for some emerging technologies, core technologies and high-tech R&D activities, the knowledge intensity is high and the professionalism is strong. Meanwhile, enterprises are often faced with the problems of high R&D cost, high risk and high uncertainty. Through cooperative

innovation research and development between upstream and downstream enterprises in the supply chain, knowledge resources and technology resources of various parties can be integrated to improve innovation possibilities, and various possibilities of technology research and development can be fully explored through cost sharing, resource sharing and complementary advantages. In addition, collaborative research and development can improve marketization efficiency. For the marketization of new products, especially emerging technology products, it is necessary to seize the opportunity to enter the market quickly and seize market shares, which requires short technology research and development cycle, high success rate of research and development, complete allocation of resources, and highly coordinated and efficient entire research and development production process. Therefore, cooperative research and development among enterprises in the supply chain can shorten the cycle of technology from research and development to production to market entry, improve the overall efficiency of the supply chain and bring excess profits to enterprises.

1.3. Supply chain innovation strategy selection and cooperative R & D coordination mechanism

In technological innovation activities, the cooperation among supply chain enterprises realizes the multi-directional and win-win sustainable development strategy of supply chain enterprises through reasonable optimization of internal innovation resource allocation and strengthening of their own professional and technical capabilities [18]. In the face of complex supply chain network and competitive market environment, how to coordinate the cooperative relationship between supply chain enterprises is the key issue of supply chain cooperative innovation. Especially for technological innovation activities in supply chain with high R&D difficulty and long R&D cycle, they are faced with R&D difficulties such as high uncertainty of R&D innovation results, asymmetry of technology level and information resources between supply chain enterprises, so the innovation decisions of supply chain enterprises largely depend on the cooperation strategies and coordination mechanisms between upstream and downstream enterprises in the supply chain [19].

In terms of supply chain innovation strategy selection, scholars generally divide innovation modes into independent innovation, cooperative innovation and imitative innovation, and find that for some technologies with long R&D cycle, high difficulty and high R&D investment, cooperative R&D is generally superior to non-cooperative R&D [20]. Manufacturers, as key nodes in the supply chain, have different main cooperation objects according to the actual demand, which can be divided into the purpose of increasing sales through cooperation with retailers and the purpose of reducing R&D costs through cooperation with suppliers [21]. With the development of supply chain management, more and more scholars have paid attention to the research of suppliers' participation in technological innovation [22], and found that the participation of suppliers in the R&D and technological innovation of new products has a positive impact on manufacturers' independent innovation ability and innovation performance [23], and is more conducive to promoting the breakthrough innovation of supply chain [24]. In addition, some scholars break through the traditional innovation R&D activities led by manufacturers, and from the perspective of

new product R&D led by suppliers, discuss the choice of independent R&D and cooperative R&D innovation strategies of suppliers in the vertical supply chain where suppliers have independent innovation ability and form a competitive relationship with manufacturers.

In terms of supply chain cooperative R&D coordination mechanism, in order to meet the collaborative innovation and deep integration of emerging technology chain and emerging industrial chain, it is urgent to realize innovation knowledge sharing and integration among enterprises. The cooperative innovation efficiency of supply chain can be improved by selecting partners with complementary resources, building innovation systems, setting up reasonable income distribution schemes, strengthening trust among cooperative members, etc. [25], and the behaviors of all partners can be reasonably restrained by contracts such as benefit distribution and cost sharing among members of supply chain in the cooperation process. Avoid the double moral hazard in the process of cooperative innovation, achieve the maximum incentive effect of R&D, and improve the overall innovation performance of the supply chain.

2. Collaborative Innovation in The Supply Chain of Emerging Technologies

2.1. Driving factors of cooperative innovation in supply chain of emerging technologies

Some researchers have found that in the vertical cooperative innovation process of the supply chain of emerging technologies, the innovation subject of the supply node will comprehensively evaluate the technical level, innovation ability and cooperation intention of enterprises with heterogeneous knowledge when looking for cooperation opportunities, and establish a contract mechanism to encourage and restrict the cooperative behavior of both parties [26] and establish a network of mutual trust. Reduce bilateral moral hazard, carry out cooperative innovation through vertical and deep linkage of supply chain, and reduce the uncertainty of emerging technology research and development. From the perspective of technology life cycle, the development of emerging technologies is in its infancy and growth stage, and technology R&D, improvement and optimization are gradually moving towards open innovation. R&d subjects seek external cooperation to revise, develop and produce technologies. At the same time, compared with other mature technologies, emerging technologies show stronger knowledge spillover in the process of cooperative R&D, which opens a "window of opportunity" for latecomers or potential entrants in the field of emerging technologies, thus improving the innovation performance of the entire emerging technology industry. However, enterprises rely on their own strength and resources to overcome the "technology canyon", high-speed technology iteration, and the evolution of emerging technologies in the uncertainty, radicalism and fuzziness promote the dependence of technological innovation subjects on external resources [27], thus stimulating the cooperation motivation among innovation subjects in the supply chain.

In addition, some studies have divided the driving forces of technological innovation into two levels: technology-driven and demand-driven. For the supply chain of the emerging technology industry, the essence of the iterative development

of enterprises is the continuous innovation of technology and the continuous development of the market [28]. Technology and market develop in synergy and promote each other. The emergence of market demand promotes technological innovation and upgrading, and technological development further promotes market demand, forming a virtuous cycle and thus forming a sound enterprise competitiveness. However, due to the high complexity and uncertainty of the R&D of emerging technologies, its rapid iteration and development require the integration of various technical resources. However, under the realistic situation, few enterprises can involve all the high-quality technical resources involved in emerging technologies. Therefore, the cooperation between nodal enterprises in the supply chain is crucial to the whole industry and the enterprises themselves.

The emerging technology industry is mainly promoted by emerging technologies, and collaborative innovation mainly occurs in knowledge acquisition, technology research and development and product development among different entities. The development of technology plays a decisive role in the development of innovation. With the development of The Times, the continuous integration of science and technology is more conducive to the vigorous development of emerging technology industry in the future. On the other hand, the integration of science and technology enables enterprises to cooperate more closely with other scientific research institutions, institutes and universities, which can enhance the competitiveness of enterprises on the technical level. At the same time, technological diversification is conducive to encouraging entrepreneurs to achieve innovation, promoting industrial development and increasing market demand. Therefore, the development of technology convergence and diversification will have a positive impact on the collaborative innovation of supply chain nodal enterprises.

In addition to technology drive, demand pull is also another important factor affecting the development of enterprise technological innovation. Only with the continuous changes in market demand can enterprises continue to encourage technological innovation, and the research and development of many emerging technology products are also determined through market research. In the early stage of the product technology life cycle, emerging technologies are prone to be affected by the market environment due to their imperfect technical performance, high price, low consumer acceptance, and unstable market position and demand. Consumer preference and product price will directly affect the change of market demand, thus affecting the upstream related technology research and development, and then affecting the content, form and efficiency of the innovation among enterprises in the supply chain node. Of course, technology push and demand pull complement each other and play different driving forces in the innovation process of emerging technology supply chain.

2.2. Cooperative innovation mode of emerging technology supply chain

Nowadays, the competition among emerging technology enterprises has gradually changed from horizontal competition among enterprises to competition among supply chains, and more and more scholars have shifted their research focus to the study of supply chain innovation cooperation mode [84]. According to different research perspectives and standards, different division methods and selection strategies of supply chain collaborative innovation

mode have been proposed. According to the leaders of collaborative innovation, there are two R&D models: manufacturer-led cooperation and innovation and supplier led cooperative innovation [29]. The organic integration of manufacturers and suppliers, through their cooperation, can obtain great benefits, which is the only way to technological innovation and development.

Supply chain with manufacturer as the core is relatively common, and manufacturer core enterprises usually have huge economic strength, advanced supply chain concept, and perfect information resource system. As the innovation subject of the supply chain, manufacturers can further cooperate with suppliers to form an innovation alliance, carry out collaborative innovation on raw materials, components and products, etc., and make innovation decisions with the most common goal of maximizing the overall profits of manufacturers and suppliers.

However, for the emerging technology industry, due to the large R&D uncertainty, high technical complexity, high R&D cost and other characteristics of the emerging technology itself, the core technology of the industry mostly exists at the supplier's end, and manufacturers need to wait for the supplier's technology research and development and upgrade for the product innovation and iteration of emerging technology. Therefore, for the emerging technology industry, The level of the supplier's research and development of new technology determines the link of the product's technological life cycle and the production trend of each node of the supply chain. In the process led by suppliers, it not only provides rich resources and technical support for product development, but also has the leading and decision-making power for the formulation of solutions. Through the participation of manufacturers, it jointly promotes the development and iteration of technology and products. Generally speaking, all suppliers are in control of core technological advantages in the supply chain innovation of emerging technologies, which increases the difficulty of industry access. A typical supplier dominated enterprise is Intel Corporation, which occupies a dominant position in the PC supply chain and holds the core technology and resources of core technology chip research and development, which enables it to have a great say in the pricing of chips, so as to maximize its earnings.

3. Summary

In general, the above studies have carried out in-depth discussions on the characteristics of emerging technology innovation, the driving mechanism, basic characteristics and cooperation methods of supply chain cooperative R&D. However, as a knowledge-intensive technology field with high research and development difficulty, emerging technologies not only rely on the interaction and fusion between related horizontal innovation entities in the innovation ecology, but also rely on the knowledge complementary series and fusion among heterogeneous enterprises with different innovation nodes in the supply chain. Existing studies have paid attention to promoting the development of industrial innovation through cooperative R&D among supply chain enterprises, and explored the collaborative innovation mode of different industries from supplier led and manufacturer led respectively. Research shows that in the process of enterprise operation, suppliers' participation in collaborative innovation of supply chain can greatly improve the performance of supply chain enterprises, and at the same time can greatly promote the progress of

innovation of emerging technologies and shorten the innovation cycle. This indicates that enterprises need the participation of external entities in technological innovation, and manufacturers are common core enterprises. They often have advanced supply chain concepts and abundant market demand resources. However, in the face of some high-tech industries, the level of suppliers' development and innovation of advanced technologies directly determines the core products, production process and division of labor of supply chain enterprises. By cooperating with manufacturers to form a technology innovation consortium, suppliers take the overall profit maximization of manufacturers and suppliers as a common goal decision. Considering the particularity of the emerging technology industry, based on the concern of the uncertain research and development results, the nodal enterprises of the emerging technology supply chain should establish a stable and efficient innovation cooperation relationship, break through the bottleneck of technology research and development and marketization, and achieve mutual benefit and win-win.

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