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RESEARCH ON KNOWLEDGE COLLABORATION AMONG SUPPLY CHAIN ENTERPRISES AND THE RELATIONSHIP WITH SUPPLY CHAIN PERFORMANCE

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Abstract

Academicians of the Chinese Academy of Engineering issued an appeal: Under the globalization of the 21st century and the general trend of the knowledge economy, China should vigorously introduce and implement knowledge management strategies to effectively improve the international competitiveness of Chinese enterprises from the management level. Knowledge management, as the cutting-edge research of management in the early 21st century, is the most effective way to realize the value of knowledge resources. However, in the face of fierce market competition and an uncertain external environment, enterprises are lagging, and closed knowledge management methods cannot meet the development needs. Only by synchronizing and coordinating operations between different enterprises through knowledge resources can we catch up with the times. The synchronous and coordinated operation of knowledge resources, also known as knowledge collaboration, is an advanced form of knowledge management and its inevitable trend of development and an efficient networked knowledge management. It is rapidly emerging between supply chain enterprise alliances. In summary, this article will start with the transformation of supply chain enterprise knowledge collaboration and supply chain knowledge to explore the deep-level operation mechanism of knowledge collaboration.The practical value of the research conclusion of this article has the following points. First, the cooperative operation of knowledge resources among member enterprises has improved the overall operation efficiency of the supply chain. Second, through knowledge collaboration, reduce the various costs of the supply chain, improve the level of innovation of member companies, and thereby enhance the overall competitive advantage of the supply chain. Third, in-depth research on knowledge collaboration among supply chain enterprises can provide decision-making basis for supply chain member companies to formulate strategic development goals.

Keywords: Knowledge Collaboration, Knowledge Transformation, Supply Chain Performance, Supply Chain Flexibility, Supply Chain Collaboration.

INTRODUCTION

Research Background

As a frontier study of management in the early 21st century, knowledge management is the most effective way to realize the value of knowledge resources (Marshall, 1997; Davenport, 1997; Luo & Tian, 2004; Li, 2006; Li, 2008; Li & Si, 2009; Meng, 2010; Lou, 2011; Feng, 2012; Li, Xie & Zhu, 2012; Hong, Yang Chen, 2013; Lu, 2013; Li, Qu & Sun, 2014). Academicians of the Chinese Academy of Engineering issued an appeal to China in the 21st century under the globalization of economic globalization and knowledge economy, China should vigorously introduce and implement knowledge management strategies to effectively improve the international competitiveness of Chinese enterprises from the management level. Combining the current background and strategic development requirements, this article aims to conduct research on knowledge collaboration among supply chain enterprises. This chapter mainly introduces the background of topic selection, the significance of topic selection, main research content, research methods, technical routes and innovations.

Problem Statement

As human society enters the 21st century knowledge economy era from the 20th century industrial economy era, traditional enterprise management models and management concepts have also gradually shifted from Taylor's scientific management theory to knowledge management theory. The different management methods that have emerged since the 20th century, such as total quality management, business process reengineering, target management, team management, etc., have laid a solid foundation for the development of knowledge management (Marlene & Marjorie, 1985; Pisano & Shuen, 1997; Teece, Pisano & Shuen, 1997; Boer, Bosch, & Volberda, 1999; Swan, Newell & Robertson, 2000; Xiang, 2001; Zhang, Li & Zhu, 2004; Song, 2005; Park, 2006; Li, 2009; Yu, 2009; Lu & Zhao, 2010; Zhu, Jiang, Du & Lu, 2011; Wang, 2011; Xu & Zhu, 2011; Ta, 2013).

The enterprise management and development strategy with knowledge management as the core has reached a consensus between the theoretical research community and the practice management community. Many well-known international companies and multinational companies, such as Microsoft, IBM, Intel, NASA, Motorola, Xerox, and Ford, etc., have introduced knowledge management concepts and methods into their own companies to ensure the stable development of enterprises. They have established their own knowledge management strategies and established Chief Knowledge Officers (CKO). More than half of the world's top 500 companies have

established a knowledge management system and implemented knowledge management. According to a 2000 research report by a well-known American consulting firm, more than 60% of large enterprises in the United States have or are in the process of introducing knowledge management, and up to 70% of large enterprises in Europe have or are in the process of introducing knowledge management. The specific benefits obtained by enterprises after introducing knowledge management are as follows: they can help companies make better decisions, they can have a better grasp of customers, they can help companies reduce costs, and they can help companies increase profits. To this end, a new wave of management change is sweeping the world. Therefore, the strategic school of knowledge management believes that knowledge management has become the final strategy to enhance the competitive advantage of an organization.

With the rise of the knowledge economy era and the maturity of knowledge management, knowledge capital is the most important resource for enterprises. Its position in the enterprise's production factors is increasing day by day, and it also plays a vital role in the process of enterprise value creation and realization. Knowledge capital is the largest intangible asset of an enterprise. The survival and development of an enterprise depends on core products, core technologies, core services, and core talents, and these core competencies depend on knowledge resources. Whether it can effectively measure, manage, and use the huge intangible wealth of the enterprise has become the core of modern management and the key to the success or failure of the enterprise. Peter Drucker, a Master of Management, and economics, believes that in the new round of economic background, knowledge is no longer comparable to social resources such as talent, capital, and land, but the only resource with far-reaching significance. Knowledge resources are the transcendence of tangible resources in the traditional sense and will eventually become the source of competitive advantages for enterprises.

Under the background of this era, enterprises are increasingly investing in knowledge management, and knowledge management is becoming more mature. However, market competition is becoming more and more fierce, and the uncertainty of the external dynamic environment is becoming stronger and stronger. In this regard, enterprises will face greater challenges, and relying on step-by-step knowledge management activities within the enterprise cannot meet the needs of development. Knowledge resources need to be synchronized and coordinated between different enterprises to enable them to keep up with the progress of the times. The synchronous and coordinated operation of knowledge resources, that is, knowledge collaboration as an advanced form of knowledge management and an inevitable trend in the development of knowledge management, is an instant networked knowledge management that is rapidly emerging between enterprise alliances (Pfeffer & Salancik, 1978; Iansiti & Clark, 1994; Ipe, 2003; Zeng, Chen & Wen, 2010; Liu, 2010; Ma & Wang, 2006; Tao & Hai, 2008; Shi & Yuan, 2009; Zhou, 2011; Wang, 2012; Kwahk & Park, 2016).

Under the impact of the new era, the traditional knowledge management model among supply chain enterprise alliances has increasingly prominent defects, mainly manifested in the following two points. First, supply chain management requires efficient and synchronized business processes, and due to the lack of synchronized knowledge exchange among member companies, it is difficult to obtain the systematic knowledge and information necessary for the overall efficiency of the supply chain to be optimal. As a result, communication barriers appear in the supply chain, making it difficult to integrate an effective whole to participate in market competition. Second, companies need to establish a series of mechanisms for knowledge sharing, knowledge transfer, knowledge acquisition, knowledge integration, and knowledge application in internal and external environments. Only by forming an effective knowledge system can we accurately grasp market needs and make effective responses to improve the efficiency and quality of supply chain operations. Under such circumstances, supply chain enterprises need to constantly adjust the management mode of knowledge capital and expand their horizons from the enterprise level to the supply chain level. Completely break the lagging and closed knowledge management mode and shift to the coordinated and synchronized operation of knowledge resources throughout the supply chain. In addition, knowledge capital has long been a source of organizational competitive advantage formation and organizational performance improvement. The focus of research on supply chain performance has also shifted from traditional resources to knowledge resources. Knowledge collaboration among supply chain enterprises has become a key factor in determining the competitiveness of supply chain enterprises. Through knowledge collaboration among supply chain enterprises, the supply of knowledge in the supply chain can be activated, and the value of existing knowledge can be improved; it can provide a fast and effective source of knowledge while reducing the cost of acquiring knowledge. Accelerate the speed of supply chain knowledge innovation and the application speed of new knowledge in member companies. Improve the coordination and consistency of enterprises on the knowledge level. Avoid repeated development of knowledge, save resources, and reduce the risk of uncertainty. These positive effects of knowledge collaboration will eventually be reflected in the improvement of supply chain performance.

To sum up, the scientific analysis of the mechanism of enterprise knowledge collaboration between supply chains and the relationship between knowledge collaboration and supply chain performance needs to be studied and resolved (Holmlund & Kock, 1996; Sabri & Beamon, 2000; Chen, Wang & Sun, 2002; Rao & Wadhwa, 2002; Garavelli & Claudio, 2003; Cheng, Wang & Cheng, 2003; Lummus, Duclos & Vokurka, 2003; Liu, Nie & Luo, 2005; Chen, 2009; Qiao, 2009; Sun & Yu, 2010; Lin & Peng, 2010; Li & Hu, 2012; Cui, Li & Qi, 2012; Das & Abdel-Malek, 2003; Fu & Zhang, 2011; Stephen, Sonya & Siva, 2012).

Research Objective

The research content of this article is as follows:

Discuss the drivers of knowledge collaboration among supply chain companies from three levels: knowledge level, node level, and supply chain level. On this basis, for the chain or network structure in the supply chain environment, from the perspective of social network, build a supply chain enterprise knowledge collaboration network model. The model includes four components: collaborative subject, collaborative object, collaborative channel, and collaborative situation. At the same time, the basic characteristics of knowledge collaboration in the supply chain network ecosystem are analyzed from the aspects of subject relevance, object complementarity, dynamics, complexity, and circulation.

LITERATURE REVIEW

Dependent Variable: Supply Chain Performance

The supply chain strategic flexibility is selected as the intermediary variable, but it is included in the dependent variable unit. After explaining the intermediary variables, enter the dependent variable section.

Strategic flexibility

Scholars of the concept of flexibility have made relatively in-depth research. From the perspective of the company's long-term strategy and long-term growth, the accurate positioning of goals, the rapid adjustment of strategic guidelines and the effective resolution of difficulties promote the improvement of the company's core competitive advantage. The flexibility studied from this perspective has been called strategic flexibility by some scholars (Hamel & Heene 1994).

Strategic flexibility examines an enterprise's ability to respond quickly and correctly in a fiercely competitive and dynamic environment from the two dimensions of resources and coordination. It is the foundation of an enterprise's survival and development. Among them, resource flexibility refers to the selectivity and applicability of enterprise resources in different ranges and under different conditions, as well as the attributes of resources that cannot be used by enterprises but can be used by enterprises through certain methods. "Resource bottlenecks" appearing in enterprise resource chains often limit the play of other resources, so resource flexibility plays a key role in the development of enterprise strategy. Coordination flexibility, which some scholars call capability flexibility, as the name implies, reflects the changes in the organization's production and operation process according to product structure and market strategy. The ability to effectively use resources in the production process by redefining the direction of resource use and resource allocation.

Coordination flexibility is essentially the identification and reconstruction of an enterprise based on cognitive resources to achieve a strategic alternative to resource use (Sanchez, 1995).

Independent Variable: Knowledge Collaboration

The word collaboration comes from ancient Greek and refers to the process or ability to combine two or more different resources or individuals to accomplish the same goal in a consistent manner.

Conceptually it can be concluded that collaboration is not new. Collaboration refers to the element-to-element coherence ability, which shows the nature of element coordination and cooperation in the overall development and operation process. The coordination and cooperation among the structural elements form a pulling effect and push things forward together. For two or more parties, the result of the collaboration benefits the individual, strengthens the whole, and develops together. The coherence that leads to the mutual enhancement of attributes between things and the development in a positive direction is collaboration.

So far, there is no unified definition of knowledge collaboration in academia. The earliest Karlenzig (2002) defined knowledge collaboration as an organizational strategy method that can dynamically integrate internal and external systems, business processes, technologies, and relationships to maximize business performance. Karlenzig also noted that "those large organizations with more than 10,000 employees can get the most out of their knowledge collaboration by doing it systematically. For them, it is necessary to build and maintain a networked knowledge process on a company-wide basis. It can bridge sectoral, regional, and cultural gaps. However, knowledge synergy should not be confined within the walls of a single company." Ling Zehua (2011) explained that knowledge collaboration is a state of effective collaboration in time and space achieved by the subject, object, and environment in knowledge management. Knowledge subjects work together in "Parallel" or "Serial". And realize the "two-way" or "multi-way" multi-dimensional dynamic process of transferring the right information and knowledge to the right object and the knowledge innovation at the right time and place. Knowledge collaboration is the advanced stage of knowledge management. Knowledge collaboration has the characteristics of punctuality in time, accuracy of target (object), multi-directionality of knowledge flow and so on. Li Dan (2009) Knowledge Collaboration is based on knowledge innovation as a collaborative goal. It integrates multiple knowledge resources and multiple collaborative capabilities and involves a process of knowledge activities that multiple organizations and individuals participate in together. The overall knowledge collaboration value created by it should be far greater than the sum of the values created by each organization when it operates independently.

Knowledge collaboration is the stage of collaborative development of knowledge management. In the knowledge management stage with "knowledge collaboration" as

the main symbol, most companies have the theme of collaboration / collaboration, sharing, and cooperative innovation. Knowledge exchange through practice communities, learning communities, interest communities, destination communities, etc. Knowledge collaboration be an ability of an organization, which can deliver the right information to the right people at the right time. Knowledge collaboration is an "activity", such as collaborative development and collaborative writing. During the event, the participating members worked hard to create personal knowledge, and eventually formed valuable results.

METHODOLOGY

Research Design

Based on combing theory and literature, this paper analyzes the dynamic process of knowledge collaboration among supply chain enterprises, constructs a two-dimensional model of supply chain knowledge transformation, and on this basis deeply analyzes the mechanism of knowledge collaboration among supply chain enterprises. According to relevant research, a hypothesis model of the relationship between knowledge collaboration between supply chain enterprises and supply chain performance is constructed, and the data is analyzed to verify whether the theoretical model and the relationship hypothesis are true. This chapter analyzes and validates the hypothesis and theoretical model of the relationship between variables proposed in the previous chapter by finding effective and reasonable empirical research methods.

Variable Descriptive Analysis

As mentioned above, there are 266 effective questionnaires recovered from the source medicines, hospitals, and patients in this study, which are large data samples. The original data samples should be summarized by describing some indicators of statistical analysis. Descriptive statistical analysis is to describe variables by means of descriptive statistics such as mean value, arithmetic sum, standard deviation, maximum value, minimum value, variance, range, average standard error, and skewness coefficient and kurtosis coefficient. In this study, six descriptive statistics of mean, standard deviation, variance, mean standard error, skewness coefficient and kurtosis coefficient are selected. The specific indicators are shown in Table 3-9.

Table 3-9 Descriptive Statistics Analysis of Variables

	Mean		Standard deviation	Variance	Skewness		Kurtosis	
	Statistics	Standard error	Statistics	Statistics	Statistics	Standard error	Statistics	Standard error

KA1	3.7526	0.06974	0.97141	0.944	-0.65	0.175	0.06	0.347
KA2	3.7216	0.06092	0.84856	0.72	-0.306	0.175	-0.198	0.347
KA3	3.5825	0.07108	0.99006	0.98	-0.442	0.175	-0.23	0.347
KB1	3.7113	0.07732	1.07692	1.16	-0.685	0.175	-0.194	0.347
KB2	3.4742	0.07131	0.99317	0.986	-0.297	0.175	-0.407	0.347
KB3	3.4536	0.06897	0.96058	0.923	-0.487	0.175	-0.137	0.347
KC1	3.5103	0.06943	0.96702	0.935	-0.377	0.175	-0.354	0.347
KC2	3.5412	0.07201	1.00303	1.006	-0.535	0.175	-0.216	0.347
KD1	3.4794	0.07131	0.99329	0.987	-0.343	0.175	-0.404	0.347
KD2	3.2577	0.08287	1.15427	1.332	-0.212	0.175	-0.726	0.347
KD3	3.1753	0.08366	1.16522	1.358	-0.128	0.175	-0.836	0.347
KE1	3.5103	0.0717	0.99865	0.997	-0.565	0.175	0.008	0.347
KE2	3.3608	0.07249	1.00965	1.019	-0.407	0.175	-0.267	0.347
KE3	3.366	0.074	1.03066	1.062	-0.467	0.175	-0.311	0.347
FA1	3.3814	0.07626	1.06224	1.128	-0.445	0.175	-0.363	0.347
FA2	3.5567	0.07121	0.99187	0.984	-0.432	0.175	-0.409	0.347
FA3	3.2062	0.07591	1.0573	1.118	-0.182	0.175	-0.384	0.347
FB1	3.5876	0.07436	1.03566	1.073	-0.718	0.175	0.186	0.347
FB2	3.3814	0.06869	0.97048	0.942	-0.486	0.175	-0.103	0.347
FB3	3.3247	0.07355	1.02442	1.049	-0.54	0.175	-0.209	0.347
SP1	3.6134	0.06817	0.94952	0.902	-0.807	0.175	0.547	0.347
SP2	3.8351	0.0647	0.90113	0.812	-0.784	0.175	0.584	0.347
SP3	3.7113	0.06735	0.93807	0.88	-0.496	0.175	-0.249	0.347

In the analysis of structural equation models, the most widely used estimation model method is the maximum likelihood method (maximum likeihood). The maximum likelihood method seeks values for the overall parameters that are most likely to explain the observed data. The maximum likelihood method must satisfy a large sample and be normally distributed and obtained by simple random sampling (Huang Fangming, 2004).

Population, Sampling and Analysis Objects

Population

The distribution of the official questionnaire for this study began in August 2017 and ended in December 2017. It lasted for nearly four months and a total of 309 questionnaires were distributed. The questionnaire is distributed mainly through the following two channels: First, relatives, friends, classmates, colleagues, etc. of myself and classmates. The second is other MBA, EMBA, DBA students studying together.

FINDINGS

Research Object

This paper summarizes the basic theories related to research and the existing literature achievements, which lays the foundation for the study of the mechanism of knowledge collaboration between supply chain enterprises. In this chapter, based on the analysis of the driving factors of knowledge collaboration among supply chain enterprises, the author builds a supply chain enterprise knowledge collaboration network model, which includes four components: collaboration subject, collaboration object, collaboration scenario, and collaboration channel. In-depth analysis of the dynamic process of knowledge collaboration among chain enterprises. According to the SECI knowledge transformation model, a two-dimensional model of supply chain knowledge transformation is constructed, and based on this, eight kinds of knowledge transformation models are explored to play a role in different knowledge collaborative behaviors. This chapter explains the internal mechanism of knowledge collaboration and provides a theoretical basis for subsequent research. The research ideas in this chapter are shown in Figure 3-1.

The research content of this chapter mainly covers the following 4 parts.

First, discuss the drivers of knowledge collaboration among supply chain companies from three levels: knowledge level, node level, and supply chain level. On this basis, for the chain or network structure in the supply chain environment, from the perspective of social network, build a supply chain enterprise knowledge collaboration network model. The model includes four components: collaborative subject, collaborative object, collaborative channel and collaborative situation. The basic characteristics of knowledge collaboration in supply chain system network ecosystem are analyzed from the aspects of subject relevance, object complementarity, dynamics, complexity and circulation.

Secondly, build a model of knowledge cooperative operation among supply chain enterprises. According to the model, the knowledge collaboration among supply chain

enterprises is interpreted as the result of knowledge sharing, knowledge transfer, knowledge acquisition, knowledge integration, knowledge application, and knowledge innovation. At the same time, there are associated phenomena such as knowledge stickiness, knowledge overlap, knowledge damage, and knowledge incompatibility, as well as auxiliary means such as knowledge evaluation and knowledge protection. Knowledge collaboration among supply chain enterprises is a dynamic and progressive process. With the emergence of new knowledge and new differentiation in the various nodes of the supply chain, enter the next round of knowledge collaboration, and thus cycle back and forth.

The classic SECI knowledge transformation model is extended to a two-dimensional supply chain knowledge transformation model, introducing new dimensions of internal knowledge and external knowledge. The process of supply chain knowledge transformation can start from any kind of knowledge state, and the knowledge transformation mode is determined by the knowledge state. Different knowledge transformation modes can be carried out simultaneously, and the same knowledge transformation mode can be advanced in both clockwise and counterclockwise directions.

Based on the above two research contents, this paper analyzes the mechanism of knowledge transformation mode in collaborative behaviors such as knowledge sharing, knowledge transfer, knowledge acquisition, knowledge integration, knowledge application and knowledge innovation. At the same time, it is believed that knowledge collaboration needs to be promoted by the knowledge transformation model. There is a relationship of mutual implication and mutual promotion between knowledge transformation and knowledge collaboration. The former realizes the change of knowledge form, and the latter completes the migration of knowledge subjects.

Research Objective 1: Driving Factors of Knowledge Collaboration among Supply Chain Companies

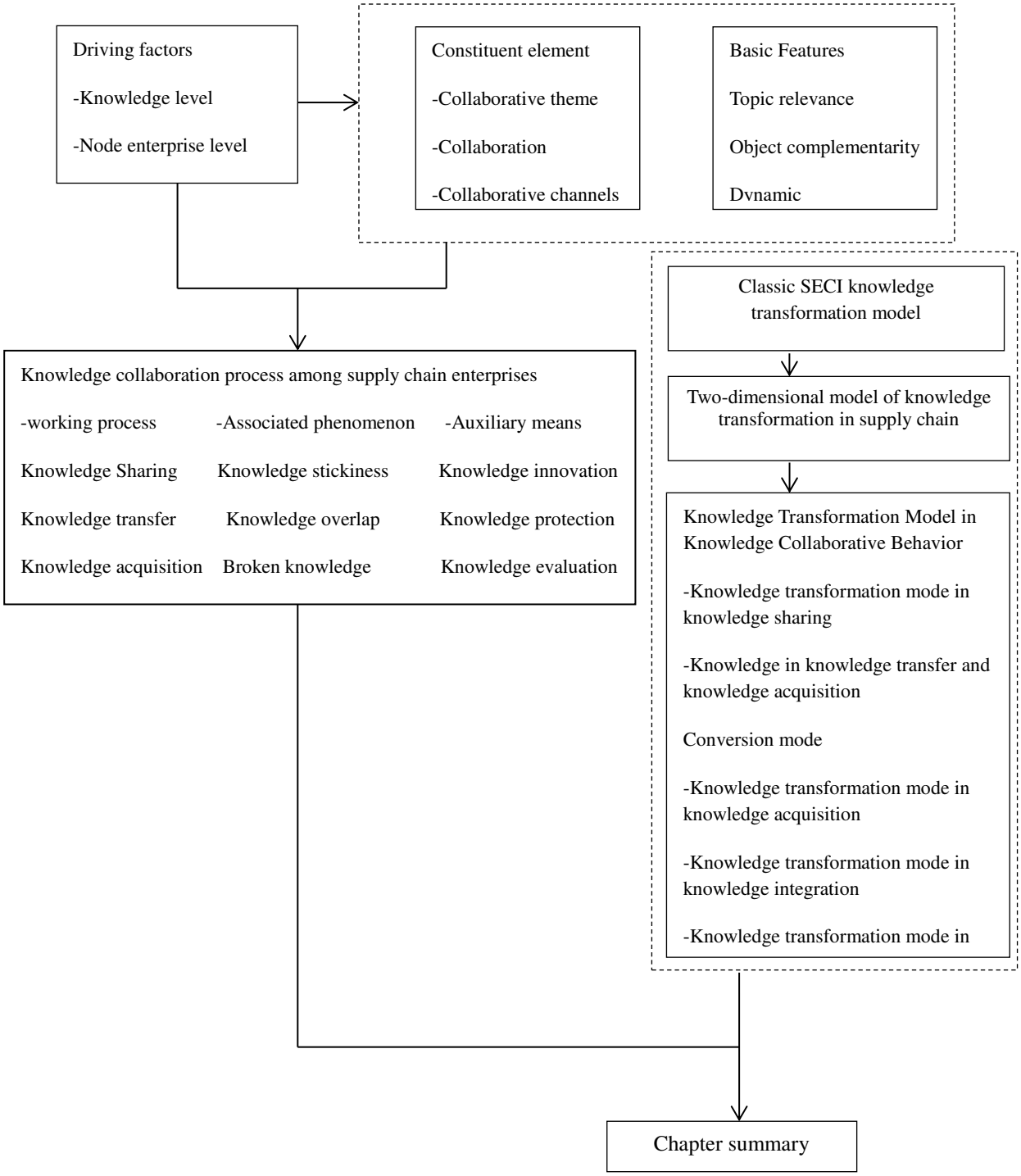
This paper studies the driving factors of knowledge collaboration among supply chain enterprises from three levels of knowledge resources, node enterprises and supply chain. Among them, the synergy driving force due to knowledge potential difference is objective. The synergy caused by the scarcity of knowledge resources of node enterprises and the alliance relationship among supply chain enterprises is subjective. As shown in Figure 4-1.

Knowledge Level

Enterprises in each node of the supply chain are in different value links and have a strong specialization. There are differences in the knowledge system and knowledge structure of the respective professional fields. This difference is called the knowledge potential difference. The knowledge accumulation of node enterprises can be divided

into horizontal knowledge potential difference and vertical knowledge potential difference according to the difference of knowledge breadth and knowledge depth. Enterprises in the same value link usually only have vertical knowledge potential differences, while enterprises in different value links have both horizontal and vertical knowledge potential differences. The smaller the knowledge potential difference between the node enterprises, the easier the knowledge collaboration among supply chain enterprises. On the contrary, the greater the difficulty of collaboration. However, when the knowledge potential difference is too small and the degree of similarity in knowledge accumulation is high, the enterprises at each node of the supply chain will lose their knowledge collaboration enthusiasm due to the high degree of knowledge overlap. When the knowledge potential difference is too large and the degree of similarity of knowledge accumulation is low, the supply chain enterprises need to spend a lot of time, energy and cost for knowledge collaboration activities, at this time the collaboration motivation will be greatly reduced. Too large or too small a knowledge gap will hinder knowledge collaboration among supply chain companies. Only if it is just right, can we ensure that each node enterprise has sufficient motivation to conduct knowledge collaboration and obtain heterogeneous knowledge resources more completely (Zhou Jie, 2010).

Figure 4-1 Research Ideas in this Chapter



Enterprise Level

According to the resource dependence theory, the knowledge among the enterprises in the supply chain nodes is heterogeneous and complementary, and the demand for scarce knowledge resources between each other has laid the foundation for knowledge collaboration. The long-term professional division of labor has made the node enterprises in different value links form a lack of knowledge types and a single situation, making it difficult to cope with the rapidly changing external environmental

environment. Supply chain enterprise knowledge collaboration can reduce the cost of knowledge acquisition, reduce the risks caused by the uncertainty of knowledge innovation, and strive for more time to develop its own core business. In addition, the repeated use of knowledge among the supply chain node enterprises not only improves the value of knowledge use and their respective knowledge stocks, but also stimulates the creation of new knowledge through knowledge reconstruction in the process of collaboration to achieve knowledge innovation. In summary, knowledge collaboration among supply chain enterprises has a significant effect on improving the competitive advantage of each node enterprise.

Supply Chain Level

Supply chain node enterprises are an alliance relationship. Under this alliance relationship, knowledge collaboration among supply chain enterprises can reduce the supply chain operating costs by optimizing the allocation of knowledge resources. First, knowledge collaboration allows knowledge to be reused among nodes, sharing the cost of knowledge R & D and innovation, and has economies of scale (Liu Chao, 2010). Second, knowledge collaboration among supply chain enterprises minimizes the "bullwhip effect", synchronizes information among suppliers, manufacturers, distributors, retailers and end customers, and quickly responds to each other's dynamic changes. Thirdly, knowledge collaboration among supply chain enterprises can enhance mutual trust, reduce the occurrence of opportunism, smooth the operation of the supply chain, and maintain the stability of the entire supply chain. In addition, enterprises at each node of the supply chain obtain knowledge innovation results through knowledge collaboration. Its essence is to enhance the overall competitiveness of the supply chain and achieve growth in the supply chain.

Network Model Building

From the perspective of social network, this paper combines domestic and foreign scholars' knowledge network model construction research results, and builds on the characteristics of supply chain environment to build a knowledge collaboration network model between supply chain enterprises, as shown in Figure 4-2.

Constituent Element

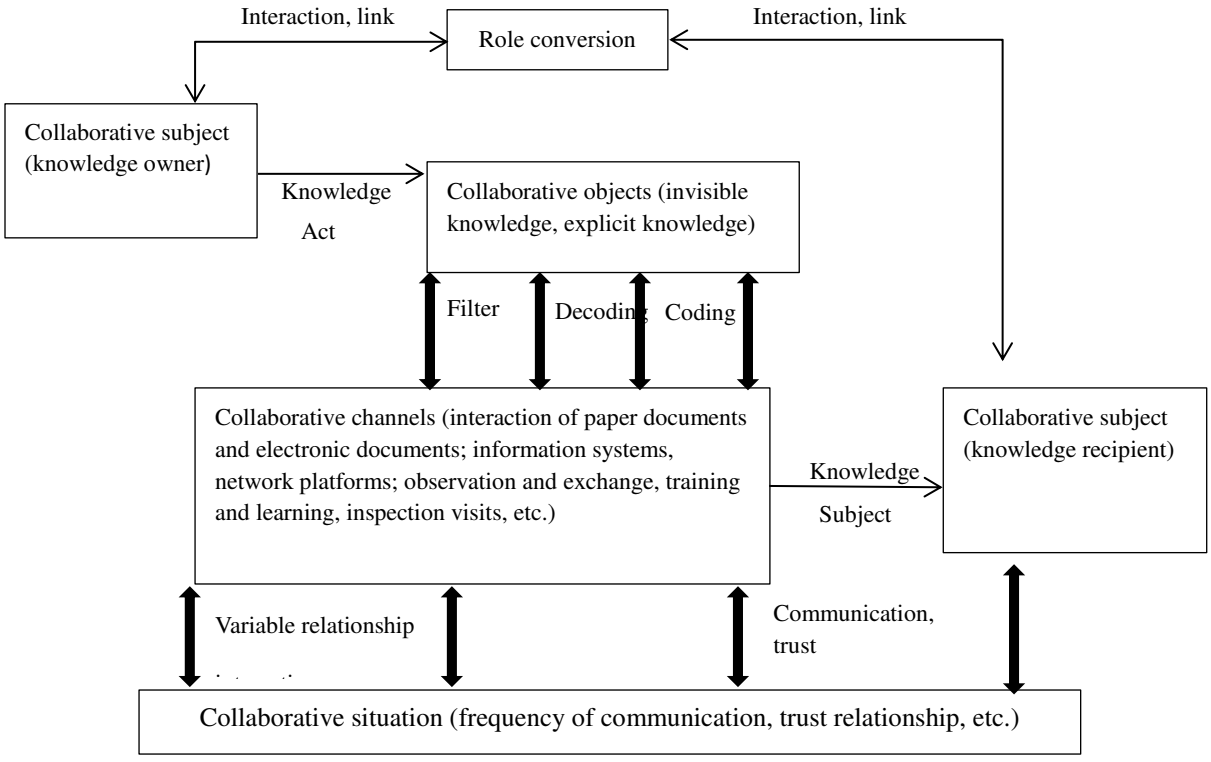
This paper builds a knowledge collaboration network model among supply chain enterprises, and its constituent elements include collaboration subject, collaboration object, collaboration channel, and collaboration scenario.

4.3.2.1 Collaborative subjects

The main body of knowledge collaboration among supply chain enterprises refers to each member enterprise and end consumer in the supply chain system (Stephen C, 2012). Under the supply chain environment, the knowledge collaboration subject has particularity in attributes and collaborative behavior. In the process of knowledge

collaboration within an enterprise, the attributes of knowledge collaboration subjects are relatively stable (Li X & Hu J, 2012), while in the context of supply chains, knowledge collaboration subjects have multiple role attributes of knowledge owner, processor, transmitter, and recipient. In terms of collaborative behavior, upstream and downstream node companies as collaborative entities can share, acquire, integrate, and process knowledge anytime, anywhere, and the frequency of knowledge application is higher. The open environment of the supply chain and the relative independence among the member companies make the willingness to cooperate with each other stronger. Various knowledge activities such as knowledge sharing, transfer, acquisition, integration, application, and innovation enrich the collaborative behavior among node enterprises.

Figure 4-2 Knowledge Collaboration Network Model among Supply Chain Enterprises



Collaborative objects

The object of knowledge collaboration among supply chain enterprises refers to the knowledge resources owned by upstream and downstream enterprises and shared in the supply chain structure. The object of knowledge collaboration directly affects the efficiency and effectiveness of collaboration. There are some characteristics of knowledge resources in the supply chain environment, which directly affect the difficulty of collaboration. Therefore, this article studies knowledge collaboration objects from the perspective of knowledge exclusivity, embedding, complexity, relevance, and complementarity (Shi Yaguang et al., 2009). The upstream and downstream enterprises of the supply chain have different fields involved due to

specialized division of labor. Their respective knowledge systems are relatively independent, and they have more proprietary knowledge. Knowledge is mostly formed in their respective long-term production practices, and knowledge resources are closely related to the context of knowledge application. Different knowledge resources are distributed in different links of value, they cover a wide range of areas, and the depth of proprietary knowledge is vertical. Knowledge resources are more complicated in both horizontal and vertical dimensions. In the supply chain environment, there is a succession of capital flows and logistics between upstream and downstream enterprises, so that there is overlap in knowledge requirements. At the same time, the knowledge resources between the knowledge activator and the knowledge passive person can make up for each other's "gap". In summary, the knowledge collaboration object among supply chain enterprises has the characteristics of exclusiveness, embedding, complexity, relevance, and complementarity.

4.3.2.3 Collaborative network

Knowledge collaboration between enterprises in the supply chain is mainly carried out through written documents and electronic documents, information systems and network platforms, interviews and exchanges between employees and observation and learning. Explicit knowledge is mostly communicated through interactive paper or electronic documents, shared information systems, and terminal devices such as computers, mobile phones, and industrial pads. Invisible knowledge is usually conducted face-to-face through formal or informal training, conversation, and visits. With the rapid development of information, big data and cloud storage technologies should be used for knowledge collaboration channels in a supply chain environment. Moreover, it integrates knowledge sources and enables knowledge to be displayed in multiple media, while combining with informal methods (Zeng Deming, 2010).

Situational collaboration

The situation of knowledge collaboration among supply chain enterprises is mainly reflected in two aspects, one is the compatibility of member companies 'corporate culture and values, and the other is the dependence of "knowledge situations" such as member companies' knowledge structure and knowledge preferences. This is reflected in the two contextual factors (Xu Shenghua, 2013) in the chain of trust and interaction frequency between upstream and downstream enterprises in the supply chain. A good knowledge coordination situation makes the frequency of knowledge interaction higher and the knowledge flow faster.

Conclusion

Although there have been phased innovations in the research on the mechanism of knowledge cooperative operation between supply chain enterprises and their

relationship with supply chain performance (Jantunen, Puumalainen, Saarenketo & Kylaheiko, 2005; Zhang, 2008; Jian & Sun, 2009; Wang & Cheng, 2010; Zhang, 2010; Wu, Wang & Shan, 2010; Yang, 2011; Bi, 2012; Lin, 2013), they also provide corresponding arguments for future research (Zhao & Wu, 2006; Xu & Zheng, 2010; Zahra, Duane & Hitt, 2000; Jian, Wu & Huang, 2008; Yao, Liu & Luo, 2008; Zhou, Wei & Hao, 2011; Xu & Xu, 2013; Lin & Zhao, 2014). However, due to the limitation of objective conditions and the lack of knowledge of the author, there are still some deficiencies in the research. The author still needs to continuously improve his scientific research ability to at least overcome it.

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